MEDICAL INSTRUMENTS

Service Manual

AVL OPTI

pH / Blood Gas Analyzer

OPERATOR'S MANUAL REVISION LOG

(Please record any changes made to this manual)

Revision Number	Release Date	Approved By	Description

Third Edition, September 1998

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PD7005 REV D

- Important Information! - Important Information! -

This **Service Manual** contains important **warnings and safety** instructions to be observed by the user.

This instrument is only intended for one area of application which is described in the instructions. The most important prerequisites for installation, operation and safety, are explained to ensure safe and reliable operation. No warranty or liability claims will be covered if the instrument is installed in areas other than those described or if the necessary prerequisites and safety measures are not observed.

The instrument is intended to be operated by qualified personnel capable of observing these prerequisites.

Only accessories and supplies either delivered by or approved by AVL are to be used with the instrument.

Due to the instrument operating principles, analytical accuracy depends on correct operation, function, and a variety of external influences beyond the manufacturer's control. Therefore the test results from this instrument must be carefully examined by licensed physician, before further measures are taken based on the analytical results.

Instrument adjustment and maintenance with the covers removed and connected to power, should only be performed by a qualified technician taking appropriate safety precautions and aware of the possible dangers of electrical shock.

Instrument repairs are only to be performed by the manufacturer or authorized service personnel.

Symbol Explanation:

This symbol is located on the inside of the instrument:

"Refer to the Operator's Manual / Service Manuals".

Symbol for instrument type B:

A B-type instrument falls under safety categories I, II or III, or has an internal power supply, providing the required insulation against discharge current and reliable ground connections.

- Important Information! - Important Information! -

- Operating Safety Information -

- This instrument falls under Safety Category I.
- This instrument is a Type B device.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Warning: Changes or modifications to this unit not expressly appoved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communication.
However, there is no guarantee that intereference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

CAUTION:

- The main power cord may only be plugged into a properly grounded socket. When using an extension cord, make sure it is properly grounded and fused.
- Disconnection of the ground lead or a loose ground connection, inside or outside the instrument, may yield unsafe or hazardous operation of the instrument. Intentional disconnection of the grounding should be avoided.
- When replacing fuses, make sure that the fuses used are of the specified type and rating. Never use repaired fuses or short-circuit the fuse holders.
- The instrument is designed as a closed conventional device which is not waterproof.
- Do not operate the instrument in an environment with explosive or hazardous gases or in the vicinity of
  anesthetic gas mixtures containing oxygen or nitrous oxide.
- The instrument is suitable for continous operation.

- Operating Safety Information -

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1 Introduction

OPTI System

General Information

This Service Manual includes information and data necessary for repair and maintenance of the OPTI 1 and OPTI CCA analyzers. The manual is intended to be used with the Operator's Manual where operating instructions and procedures are described. In order to fully utilize the described procedures in this manual, it is necessary to be familiar with the operation and handling described in the Operator's Manual.

To ensure proper operation and performance which meets the analyzer specifications, maintenance and repairs must be performed according to the instructions described in this service manual. The use of AVL original parts and recommended materials is required to achieve performance specifications. Spare parts and the proper order numbers are described in Chapters 10 and 11.

Product warranties may vary by country. Specific warranty terms and conditions are described in documents provided at the time of installation.

Warnings

Warnings in this manual are marked with CAUTION and describe situations or potential dangers that may be hazardous to personnel performing maintenance or service activities. Information marked with NOTE describes situations or hazards, which can cause damage or analyzer malfunction and should be avoided. The following general operating conditions should be strictly adhered to:

- Never operate the analyzer near flammable or explosive gases.
- Check the supply voltage before connecting the analyzer to local AC power.
- When operating the analyzer connected to primary AC power, always connect it to a properly grounded 3-pole power receptacle.
- Replace damaged or worn power cables or plugs.
- Before opening the rear cover, turn off the analyzer and disconnect the power cable from the primary AC source.
- Replace fuses with approved or original types only.

- Operate the analyzer away from sources of liquids such as sinks or wash basins.
- Avoid leakage or spilling of fluids inside the analyzer, which may damage the electrical assemblies.
- Clean the analyzer surfaces with only a mild soapy solution as necessary. Avoid strong or harsh chemical cleaning agents that may damage the analyzer housing and surfaces.
- Use proper tools and test equipment as described in this manual to complete testing and repairs.
- Analyzer surfaces may be contaminated from contact with blood. Always use precaution when contacting these surfaces.
- Use approved protective gloves when handling blood specimens of contacting contaminated surfaces.
- Adhere to local regulations when disposing of OPTI cassettes or contaminated parts.

2 General Description

Specifications

Measurement Parameters

The specifications are described for both the OPTI 1 and OPTI CCA analyzers. Certain parameters are specific only to OPTI CCA analyzers. The specifications listed below are valid for human whole blood, pH of human plasma, serum, and approved QC-material.

Validated Measurement Range	Range	Display Resolution (Lo / Hi)	Units
pH	6.6 - 7.7	0.01 / 0.001	pH units
PCO_2	10 - 120	1 / 0.1	mmHg
PO_2	20 - 500	1 / 0.1	mmHg
Na+	100 - 180	1 / 0.1	mmol/L
K+	0.8 – 10.0	0.1 / 0.01	mmol/L
ctHb	5 – 25	0.1	g/dL
SO_2	60 – 100	1 / 0.1	%
Barometer	300 - 800	0.1	mmHg

Input Values		Range *	Default Value
Patient Temperature	Temp	14 - 44 °C 58 - 111 °F	37.0 °C 98.6 °F
Total Hemoglobin	tHb	1 - 26 g/dL 1 - 16 mmol/L 1 - 260 g/L	15.0 g/dL 150 g/L
Hemoglobin type		adult / fetal	adult
MCHC		30.0 – 37.0	%
P_{50}		15 - 40 mmHg	26.7 mmHg
FIO_2		0.21 - 1.0	0.21
Respiratory Quotient, RQ		0.7 - 2.0	0.84
Patient Id		11 digits max.	
Patient Sex		male / female / ?	? (unknown)
Operator Id		11 digits max.	

*SI units are also available.

Calculated Values		Range	Display Resolution	Units
Base excess in vitro	BE	-40 - +40	0.1	mmol/L
Base excess in vivo	BEecf	-40 - +40	0.1	mmol/L
Base excess actual	BEact	-40 - +40	0.1	
Buffer base	BB	0 - 100	0.1	mmol/L
Actual bicarbonate	HCO_3^-	1 - 200	0.1	mmol/L
Total CO_2	TCO_2	1 - 200	0.1	mmol/L
Standard bicarbonate	$stHCO_3^-$	1 - 200	0.1	mmol/L
Standard pH	stpH	6.5 - 8.0	0.001	pH units
Oxygen saturation	O_2sat	0 - 100	0.1	%
Oxygen content	O_2ct	0 - 56	0.1	vol%
Hydrogen ion concentration	cH^+	1000 - 10	0.1	nmol/L
Alveolar-arterial oxygen partial pressure difference	AaD O_2	0 - 800	0.1	mmHg
P50	P50	15 - 35	0.1	mmHg
Anion Gap	AnGp			
Normalized Ca++	nCa++			
Hematocrit, Calculated	Hct(c)	15 - 75	1	PCV%

Data Management

Printout	built-in thermoprinter	
Serial Interface	1x RS 232, 9-pin SUBMIN D/F	ASCII or ASTM
Infrared Interface	1XIR (Unidirectional or Bi-directional)	ASTM

Gas Supply

Calibration Gas	14 % O_2, 6 % CO_2, balance N_2, max. pressure 145 psi (10 bar)

Operating Parameters

Sample type	Heparinized whole blood, plasma/serum (pH only), AVL approved quality control materials
Sample input device	syringe, capillary, microsampler
Sample size	OPTI 1 80µL OPTI CCA 125µL
Sample input	automatic aspiration
Analysis time	< 2 minutes
Type of measurement	Optical fluorescence and reflectance
Units	conventional, standard international (SI)

Temperature / Humidity

Ambient temperature	15 °C - 32 °C (60 °F - 90 °F)
Measuring chamber temperature	37 °C ±0.1 °C (98.6 °F ±0.18 °F)
Relative humidity	5 - 95 % non-condensing

Electrical Supply

Voltage range	90 - 250 VAC,
Frequency	50 - 60 Hz
Power consumption	typical 110 VA

Classification

Safety category	I
Instrument type	B (following ÖVE - MG/EN 60 601-1, IEC 601-1 with optional power supply)
Operation type	For continuous operation
Protective system	IP20
Ex - protection	The device is not specified for operation inside explosion hazardous areas.

Dimensions / Weight

Height	4.875 inches (12.4 cm)
Width	14.25 inches (36.2 cm)
Depth	4.75 inches (27.8 cm)
Weight	10.5 pounds (4.8 kg) with battery

Acoustic Noise Level

standby	28 dbA
ready	28 dbA
wash/dry	60 dbA
measurement	43 dbA

Test Certificates

CSA
CE

Principles of Operation

Luminescence is the emission of light energy resulting from "excited" molecules returning to a resting state. When luminescence is initiated by light, it is commonly referred to as fluorescence. When a fluorescent chemical is exposed to light energy of an appropriate "color", electrons in the molecules of the fluorescent chemical are "excited". A very short time later, the electrons return to a resting state and in this process sometimes emit a small amount of light energy. This energy is less than the excitation energy and thus has a different color. That is, the emitted light (fluorescence emission), is red-shifted from the excitation light and is much less intense.

Fluorescent optodes (from **opt**ical electr**odes**) essentially measure the intensity of light emitted from fluorescent dyes. The emitted light is distinguished from excitation light by means of optical filters. Because the excitation light energy is kept constant, the small amount of light that results is changed only by the concentration of the analyte. The concentration of the analyte is determined by the calculation of the difference in fluorescence measured at a known calibration point and fluorescence measured with the unknown concentration of analyte.

The PO_2 optode measurement principle is based upon luminescence, first documented in the 1930's, and commercially utilized to measure blood PO_2 in 1983. The relationship of luminescence to PO_2 is quantified by the Stern-Volmer equation which describes how the fluorescence emission intensity "I" is reduced as the PO_2 "P" is increased. Unlike conventional electrochemical "Clark" PO_2 electrodes, the oxygen optode does not consume oxygen molecules during the measurement.

The pH optode measurement principle is based upon pH-dependent changes of the luminescence of a dye molecule immobilized in the optode. Chemists have used such pH indicator dyes for many years to perform acid-base titrations in turbid media. The relationship of luminescence to pH is quantified by a variant of the Mass-Action Law of chemistry that describes how the fluorescence emission intensity increases as the blood pH is increased above the dye's characteristic pKa. pH optodes do not need a reference electrode to measure pH; however, they exhibit a small sensitivity to the ionic strength of the sample being measured.

The PCO_2 optode measurement principle is based upon placing a pH optode behind an ion-impermeable membrane, just as conventional PCO_2 blood gas electrodes employ the Severinghaus CO_2 electrode construction. As such, PCO_2 optodes suffer from non-selective interference from volatile acids and bases in blood just as conventional PCO_2 electrodes.

During the measurement, light originating from lamps in the analyzer is passed through optical filters so that specific colors are transmitted to the sensors, causing them to emit fluorescence. The intensity of this emitted light depends upon the partial pressure of oxygen (PO_2), carbon dioxide (PO_2) or hydrogen ion concentration (pH) of the blood in direct contact with the sensors, as described above. The light emitted by the fluorescent sensors passes through lenses and additional optical components. A filter is used to isolate specific colors of interest from this returning light for measurement by a light detector.

The Na and K ion optodes are based upon the principle of Ion Selective Electrodes (ISE's). The optodes use ion selective recognition elements (ionophores) similar to those used in ISE's, however the ionophores are linked to fluorescent dyes instead of electrodes. These types of dyes have been used since the 1970's to visualize and quantify cellular ion levels in fluorescence microscopy and cell counters[8]. As the ion concentration increases, these ionophores bind larger amounts of ions and cause the fluorescence intensity to increase or decrease, depending on the particular ion. Like the pH optode, the ion optodes do not need a reference electrode, however they do exhibit a small pH sensitivity that is automatically compensated in the AVL OPTI using the measured pH.

The measurement of total Hemoglobin (ctHb) and oxygen saturation (SO_2) uses the well-established principle of optical reflectance. Red and infrared light a three wavelengths is directed at whole, non-hemolyzed blood within a precisely defined part of the cassette over the O2 optode. The photons are partially absorbed and reflected by erythrocytes in a manner proportional to hemoglobin level; at low hemoglobin levels the unabsorbed photons strike the O2 optode's pink overcoat and are reflected back up through the blood a second time. A portion of the reflected light exits the top of the cassette and is measured by a detector in the instrument. The infrared wavelengths are selected for the hemoglobin measurement because they are largely independent of SO2, that is, the predominate forms of adult and fetal hemoglobin absorb similarly within the 750 – 850 nm wavelength range. The red wavelength is utilized for the SO2 measurement because it is much more strongly absorbed by deoxyhemoglobin than all other hemoglobins, and is picked close to the isobestic point for oxy- and carboxyhemglobin. Maintaining high shear force just prior to measurement minimizes sensitivity to erythrocyte aggregation (rouleau formation).

The optical signal of the detectors is converted by the microprocessor to a numerical readout in conventional units of measure and displayed on the front of the device. Other values commonly used for the assessment of oxygen and acid-base status are calculated from these measured values.

The entire sample path of the OPTI cassette is filled with storage buffer to keep the sensors stable during storage. In addition, the cassette pouch is filled with a CO_2 atmosphere, which keeps the pH of the storage buffer stable.

The cassette not only contains the sensors but also houses a distribution valve (cassette valve), the sample fill port, an input/output port (I/O port), a reservoir and a vent.

The function of the I/O port is to connect the cassette to the peristaltic pump allowing sample aspiration and calibration gas to flow through the cassette.

The storage buffer in the reservoir ensures stability over the shelf life of the cassette.

The distribution valve has 2 functions: its hollow body serves as a waste container, referred to as “waste”, holding storage buffer and OPTI-trol. In addition, the cassette valve incorporates small channels, called links that connect the sensor channel, the fill port, the vent and the I/O port in different combinations. These different connections are achieved by turning the cassette valve to different positions. Each valve position has an assigned number. An unused cassette is set to position 0, the home position. The diagram on page 2-9 shows the valve positions and the connections for each position. E.g., position 2 connects the fill port via the valve link to the sensor channel and the reservoir to the I/O port.

The OPTI 1 and OPTI CCA analyzers are microprocessor-based instruments measuring optical fluorescence. The disposable, single-use cassette contains all the elements needed for calibration, sample measurement and waste containment. After reading the calibration information specific to a cassette into the instrument by 'swiping' the cassette package through a convenient bar code reader, the cassette is placed in the measurement chamber. While the analyzer warms the cassette to 37.0 ± 0.1 °C, the cassette valve is turned to position 5. In this position, the I/O port is connected to the vent allowing the pump to purge calibration gas. At the same time, readings are taken from all sensors to ensure proper functioning. In addition, the fluid light gates L1, L2 and L3 are calibrated.

Then the valve turns to position 1 which connects the I/O port to the reservoir and the cassette sensors to the vent via the waste. The pump starts pushing the storage buffer into the waste. L1 and L2 monitor the movement of the buffer and the pump rate. After the buffer is pushed into the waste, the valve turns to position 4, which connects the I/O port to the reservoir and the sensors directly to the vent. The pump

first purges the cassette with calibration gas, then slows down during the actual gas calibration passing the gravimetrically prepared gas mix across the sensors. The pH sensor is calibrated via the precision storage buffer. Calibration is completed when stable readings of all sensors are obtained. The calibration process lasts from 15 to 80 seconds.

After calibration verification, the cassette valve turns to position 8 closing off all ports. The instrument now waits for aspiration of sample fluid.

After pressing the J key, the valve turns to position 2, which connects the fill port to the sensor channel and the reservoir to the I/O port via waste. The pump starts aspirating the sample. During aspiration, the sample light gates L1 and L2 check for sample type (blood or clear fluid), bubbles and sufficient sample volume.

Once the sample has been aspirated successfully, the valve turns again to position 4. After a short warm-up period, readings are taken from all 3 sensors. Once stable readings are obtained, the valve turns to position 8 closing off all ports. The results are calculated and the cassette is ready for disposal.

In case of an OPTI-trol measurement (OPTI 1 only), the user has the option of terminating the measurement or introducing a subsequent blood sample. If a blood sample is introduced, the OPTI-trol is purged into the waste and the blood sample is aspirated and analyzed.

Fluidics Block Diagram

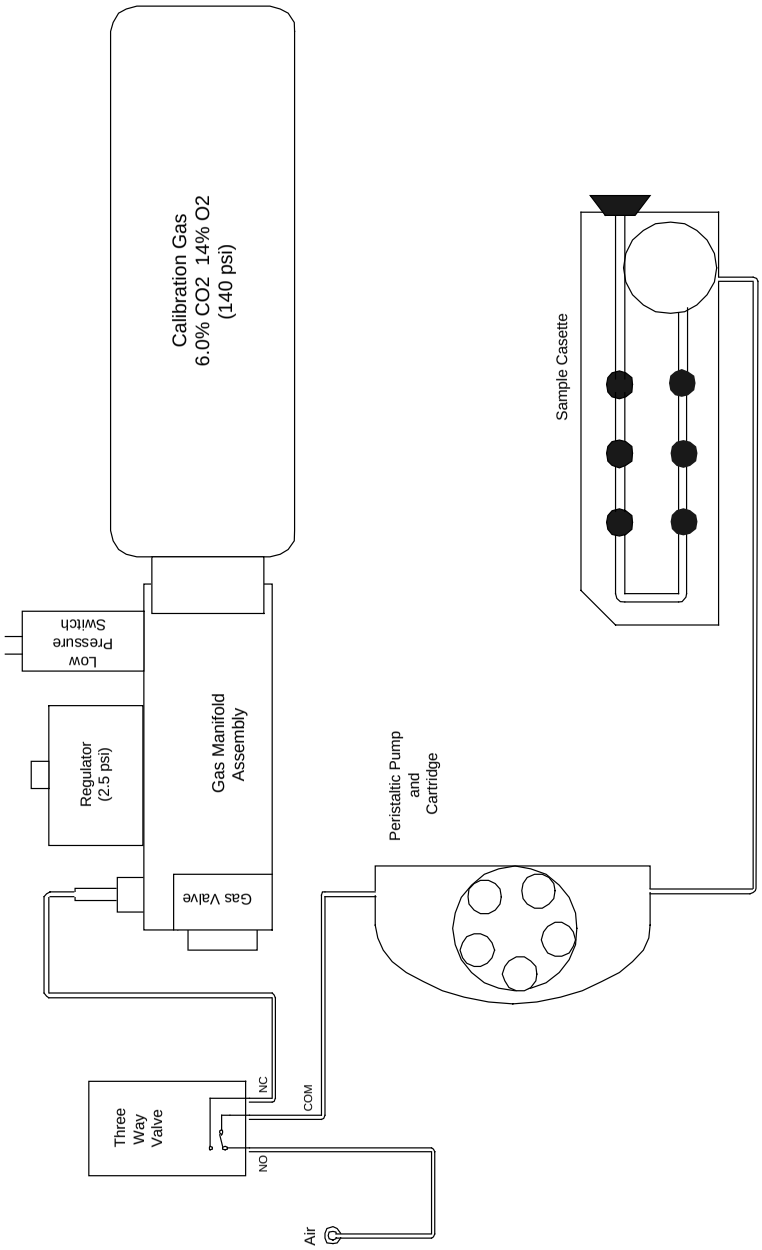


Fig. 2-1: Fluidics Block Diagram

OPTI Cassette

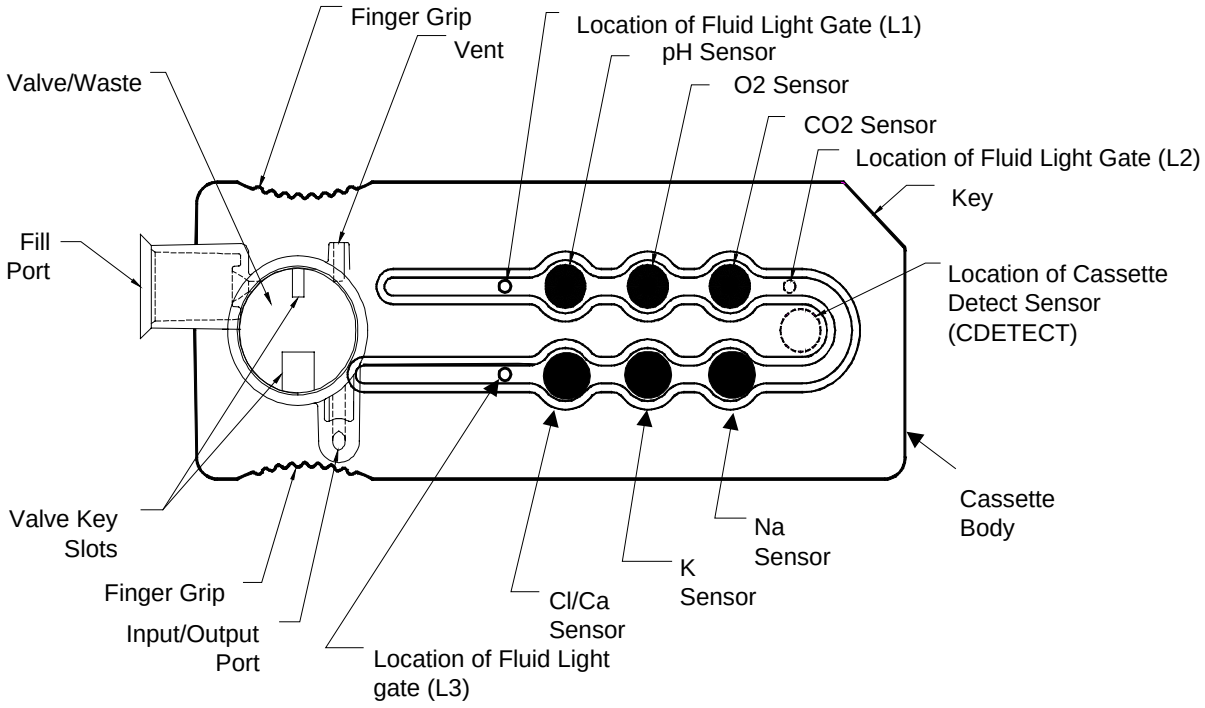


Fig. 2-2: OPTI 1 Cassette

OPTI Cassette Valve Positions

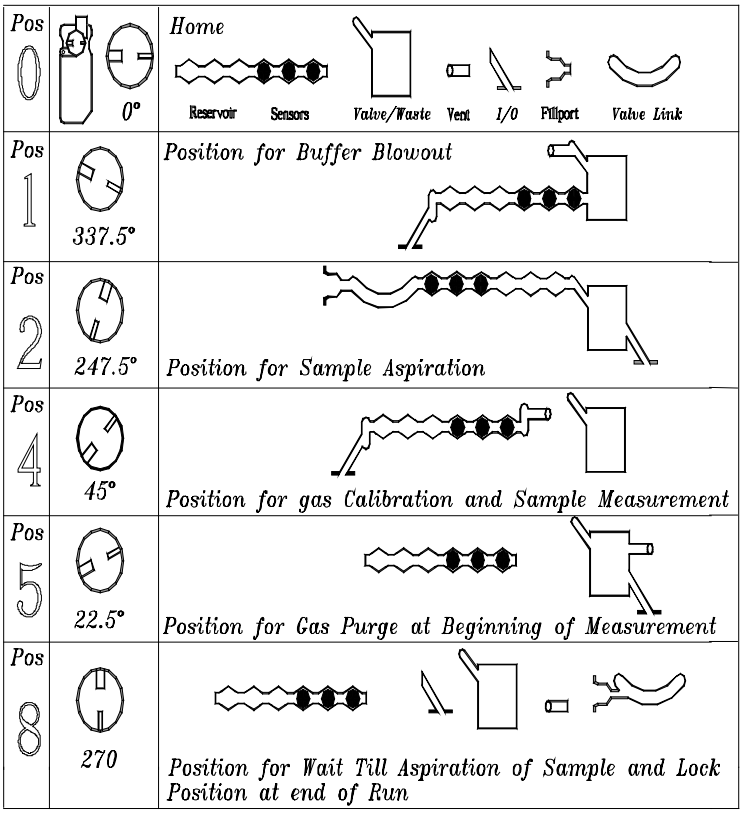


Fig. 2-3: OPTI Cassette Valve Positions

Assemblies

The OPTI consists of several major components and assemblies that control the operation of the analyzer. A brief function description of the assemblies is provided below.

Valves

Valve — The gas valve module controls the delivery of the internal calibration gas. The gas valve module incorporates a pressure regulator, pressure sensor, gas valve and a three-way valve.

Vdrive — The valve drive assembly is a stepper motor that controls the positioning of the cassette valve.

Pump — The peristaltic pump assembly is a stepper motor and pump cartridge that provides for the pump flow used to transport sample and calibrator material through the cassette.

Modular Components

- The sample measurement chamber (SMC) assembly provides thermostated heating control of the measuring chamber at 37 °C ± 0.1 °C (98.6 °F ± 0.18 °F).
- The optics module is a microprocessor-based assembly that houses the optics detectors, preamplifiers and processing circuitry for optode sensor signals.
- The main board includes the main microprocessor, RAM and EPROM memory and control circuitry for the LCD display, keyboard, printer motors, barcode and serial interface.
- The OPTI Cassette contains the optode sensor used to measure the sample and also includes the reservoir for reagent and sample waste.
- The OPTI CCA (only) SMC Cover provides optics and processing circuitry for ctHb/SO2 measurement.
- A minimal amount of tubing is used in the OPTI system.
- Storage compartment.
- Liquid crystal display, 2 lines x 24 characters per line.
- Keyboard with numeric keys, l and r keys, J and E keys.
- Thermoprinter.
- Serial RS 232 C - interface
- Barcode reader

Software Structure

The OPTI software is designed to provide a simple user interface organized in a menu fashion. The operator may select a menu function by using the l and r keys to move to the desired menu selection. The menu function to be selected will be blinking. Pressing the J key will select the desired menu item.

The following system software menus are provided in flow chart format and show the software menu structure:

Main Menu

Sampling Menu

Run Menu

Data Menu

Setup Menu

Diagnostic Menu

QC - Range Setup Menu

Main Menu – OPTI 1

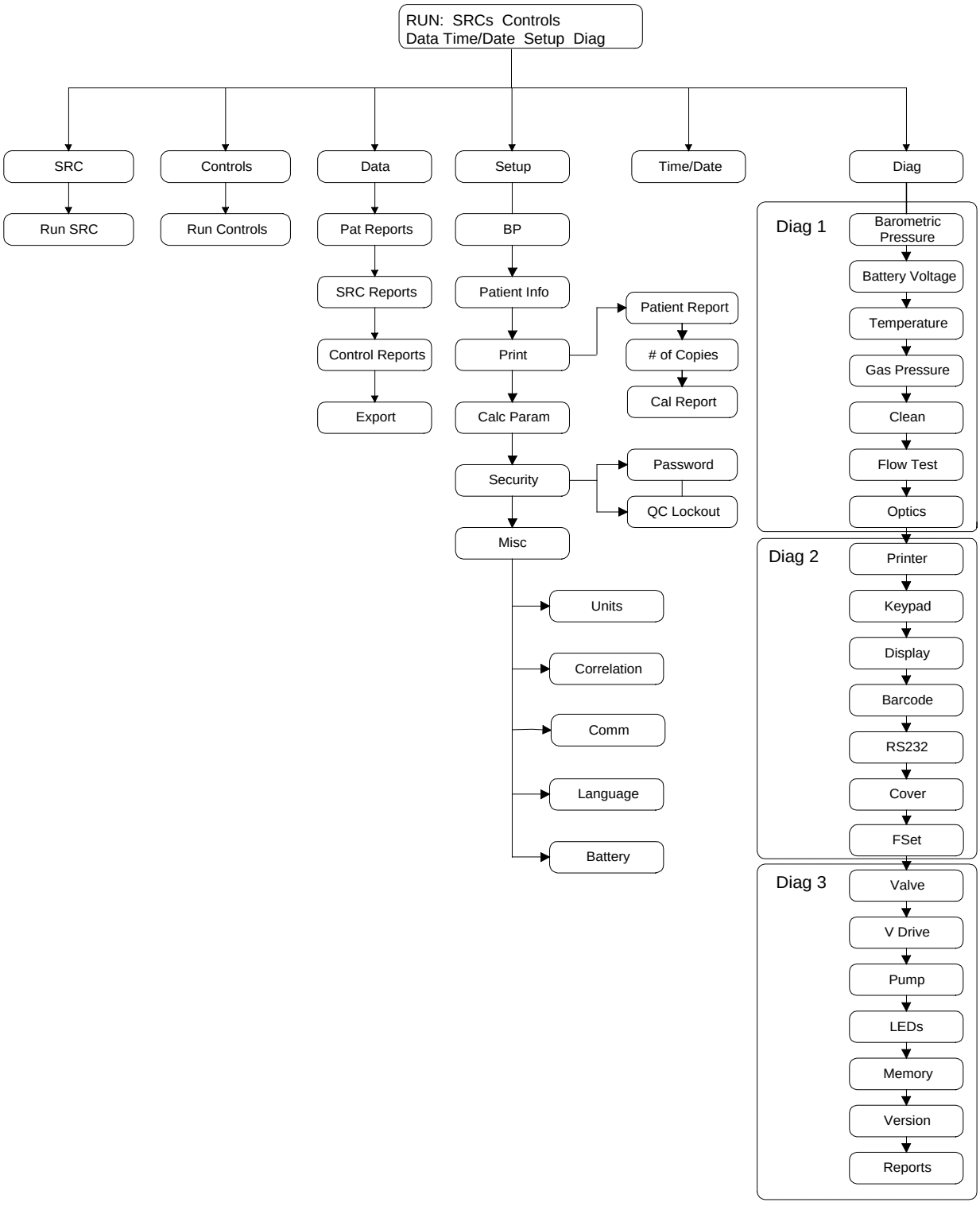


Fig. 2-4: Main Menu

Sampling Menu – OPTI 1

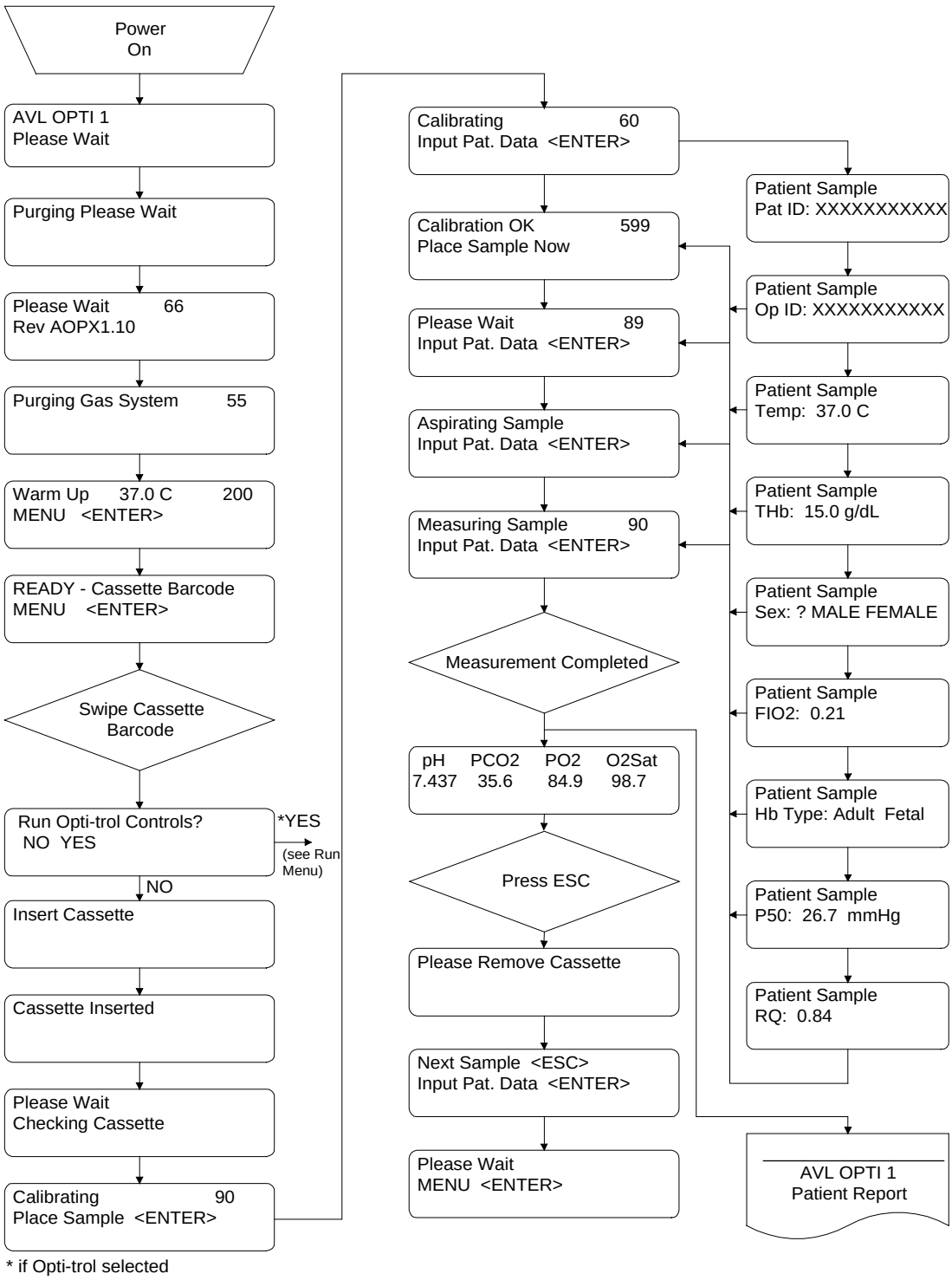


Fig. 2-5: Sampling-Menu

Run Menu – OPTI 1

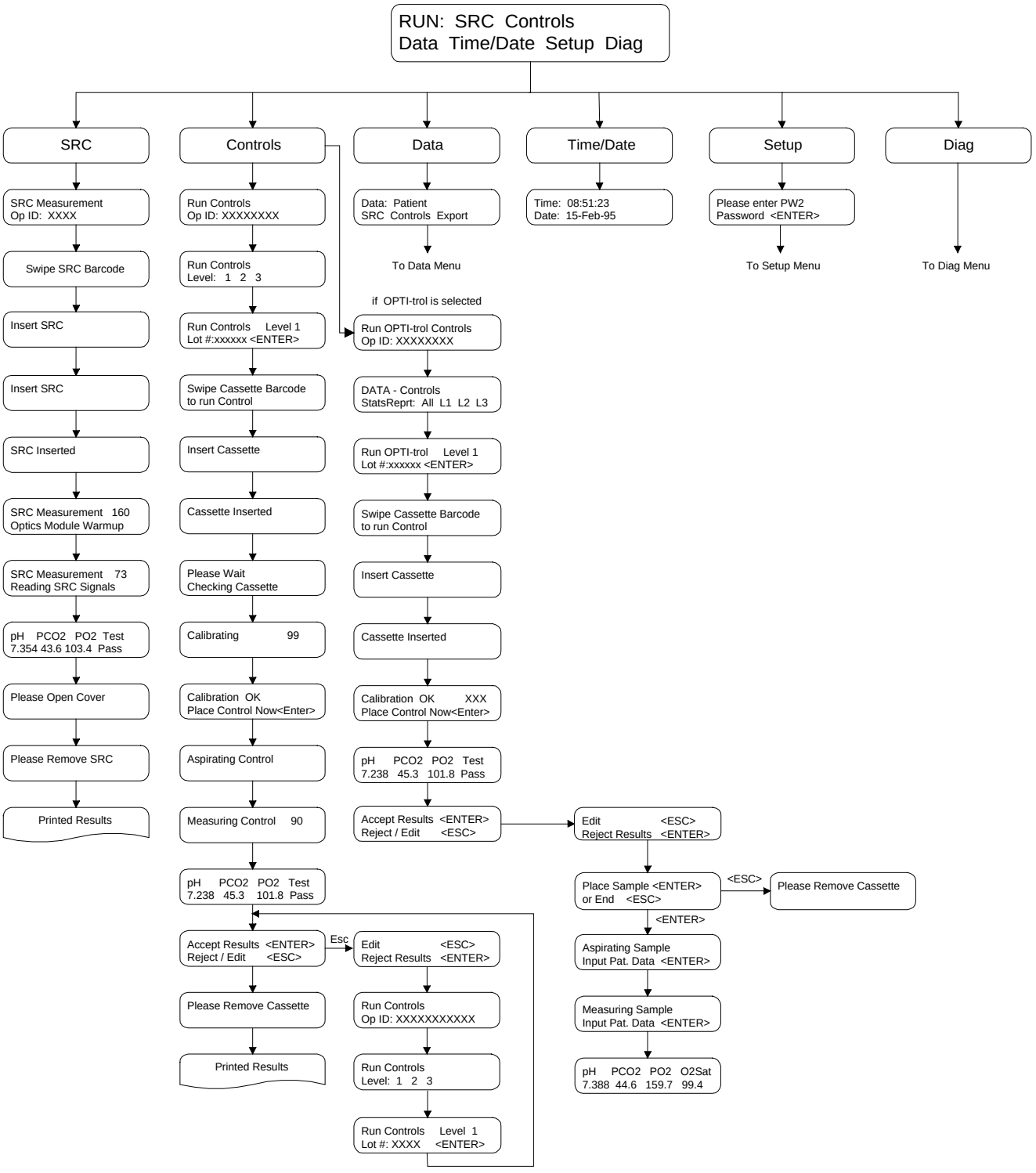


Fig. 2-6: Run Menu

Data Menu – OPTI 1

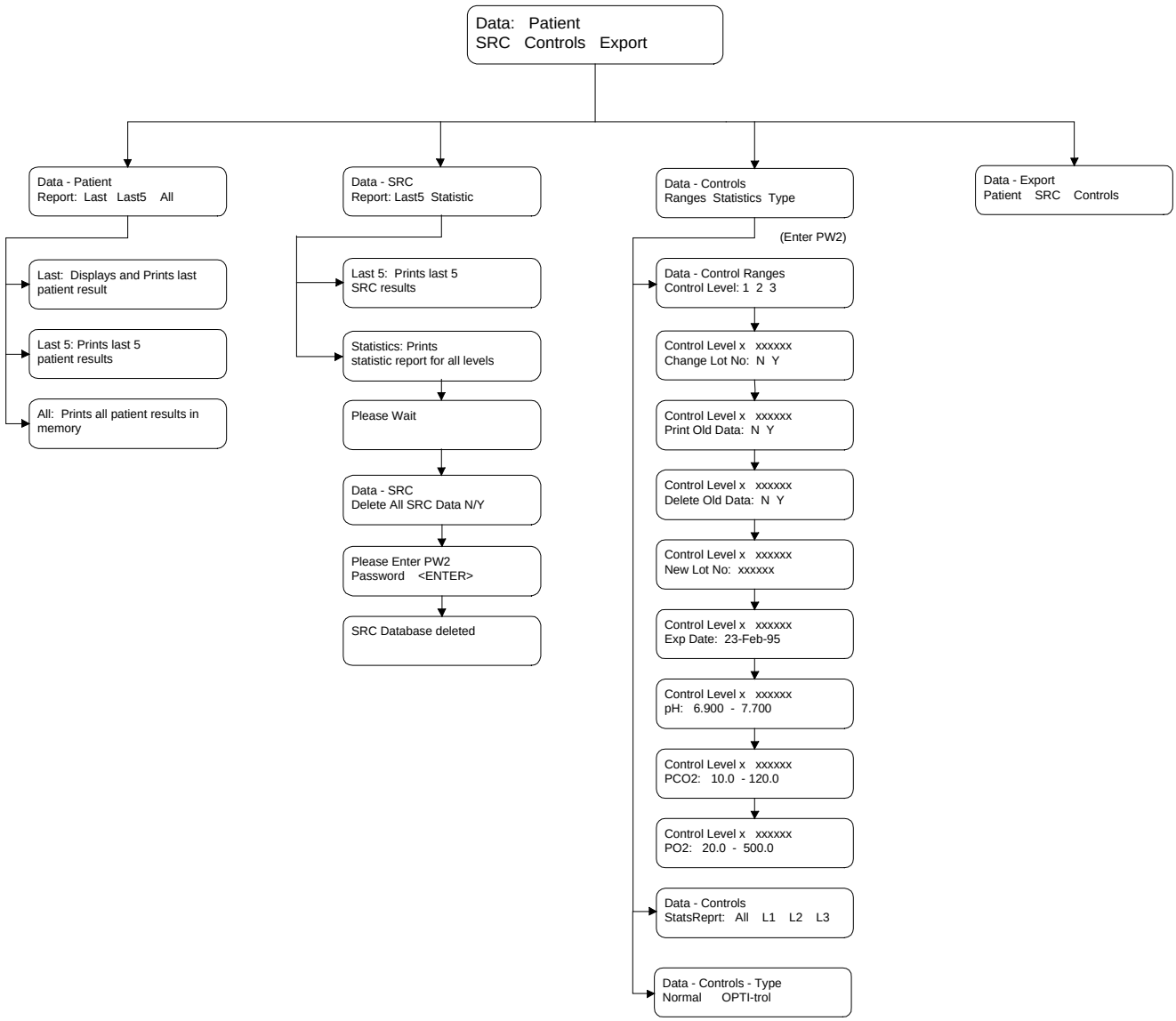


Fig. 2-7: Data Menu

Setup Menu – OPTI 1

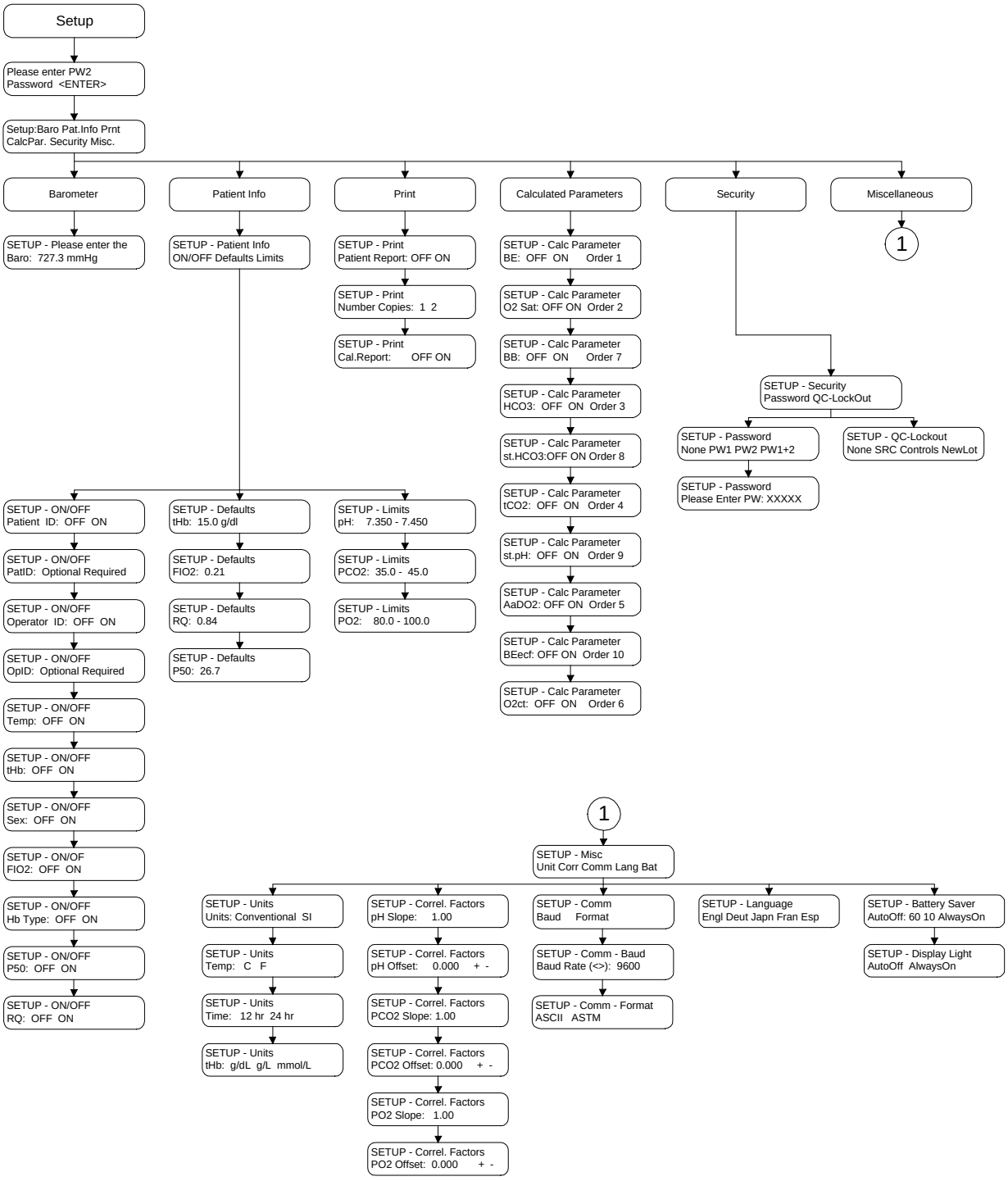


Fig. 2-8: Setup Menu

Diagnostic Menu – OPTI 1

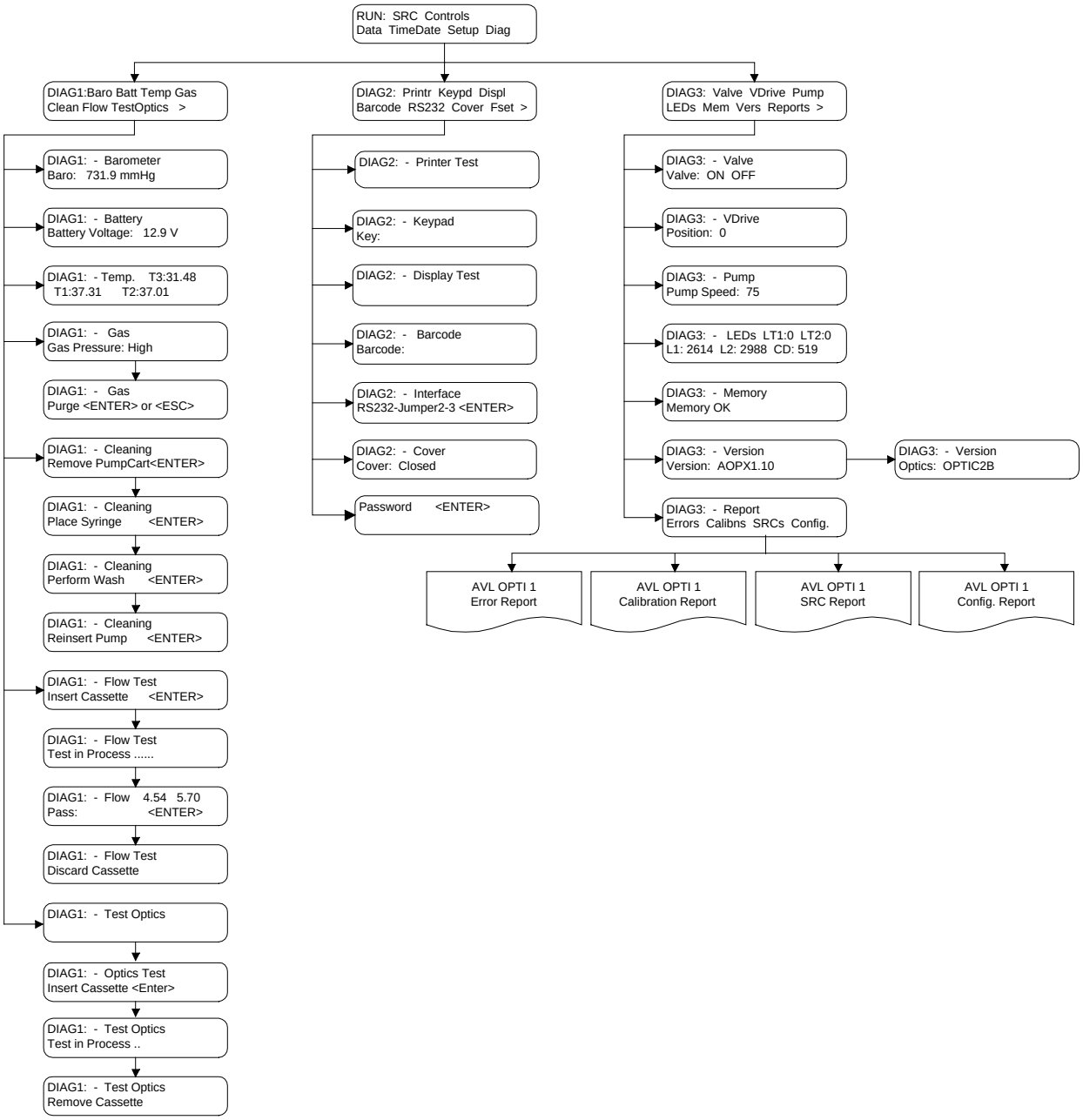


Fig. 2-9: Diagnostic Menu

QC-Range Setup – OPTI 1

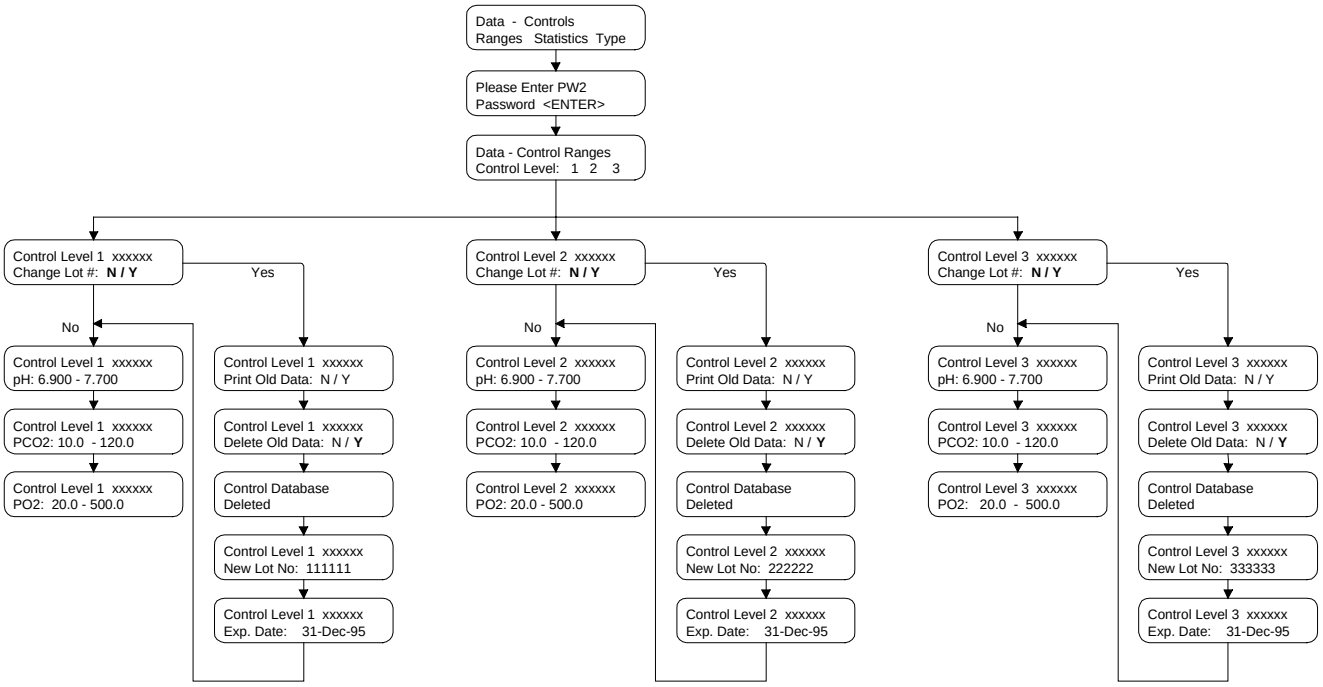


Fig. 2-10: QC Ranges Setup

Main Menu – OPTI CCA

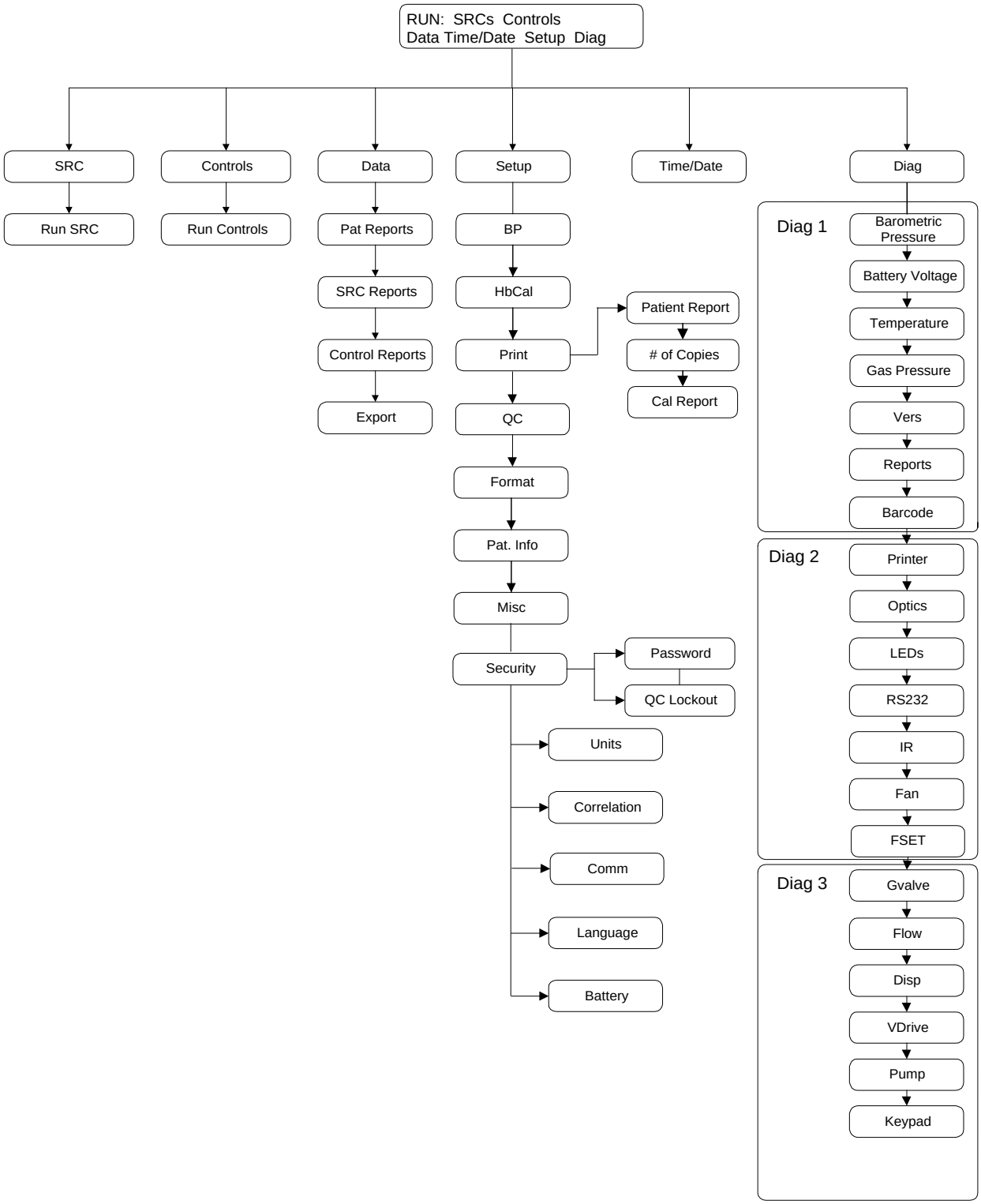


Fig. 2-11: Main Menu

Sampling Menu – OPTI CCA

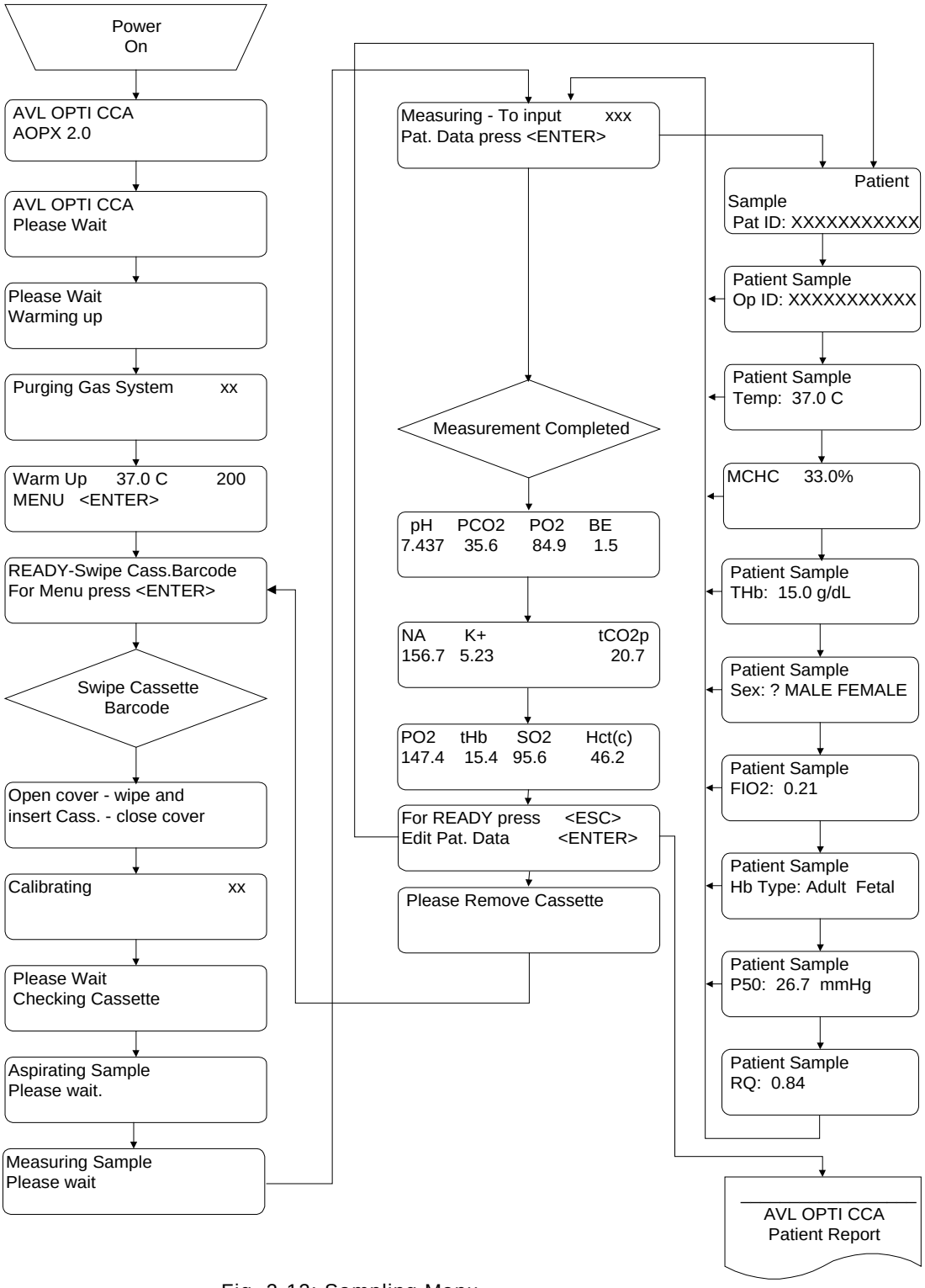


Fig. 2-12: Sampling Menu

Run Menu – OPTI CCA

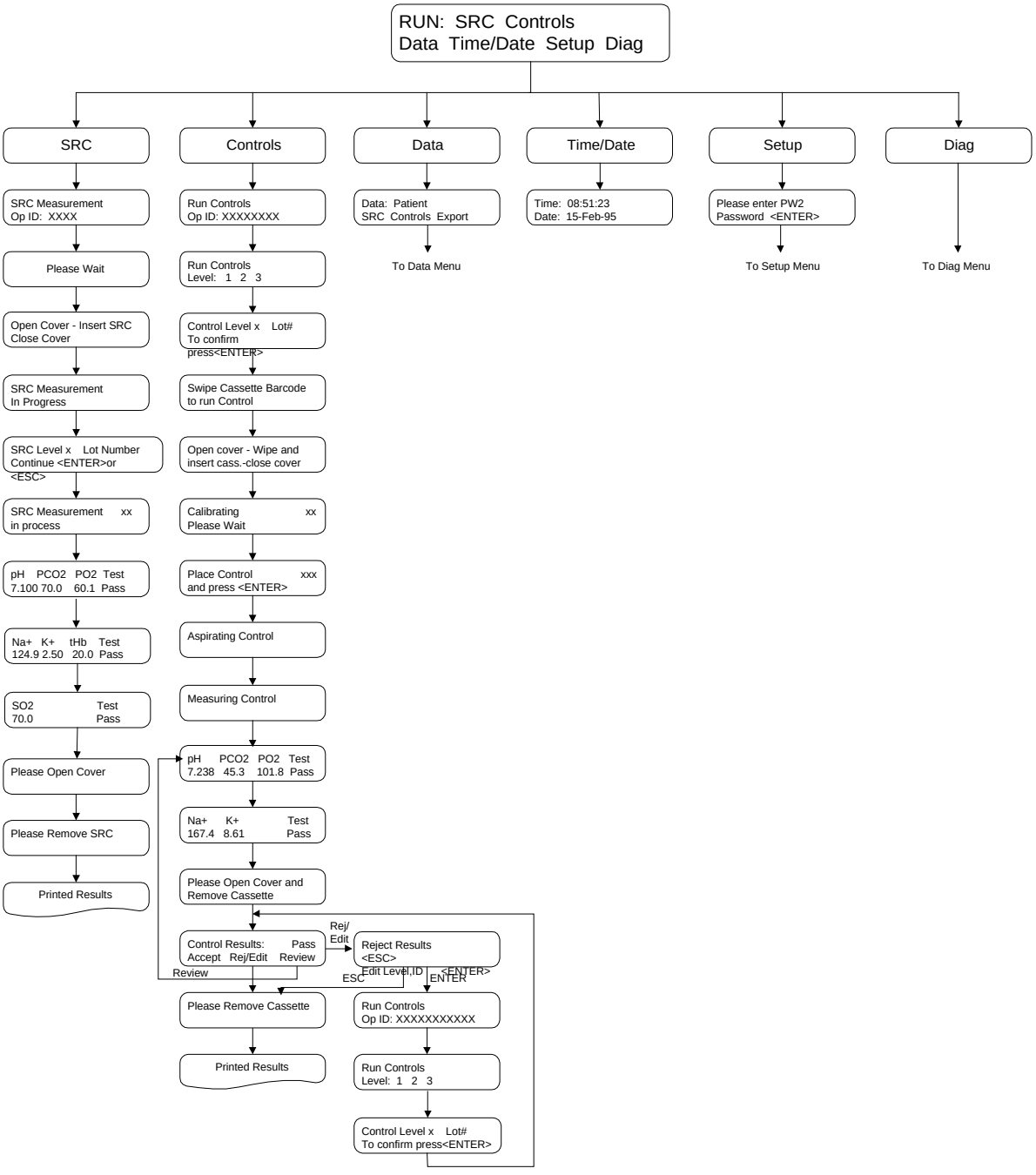


Fig. 2-13: Run Menu

Data Menu – OPTI CCA

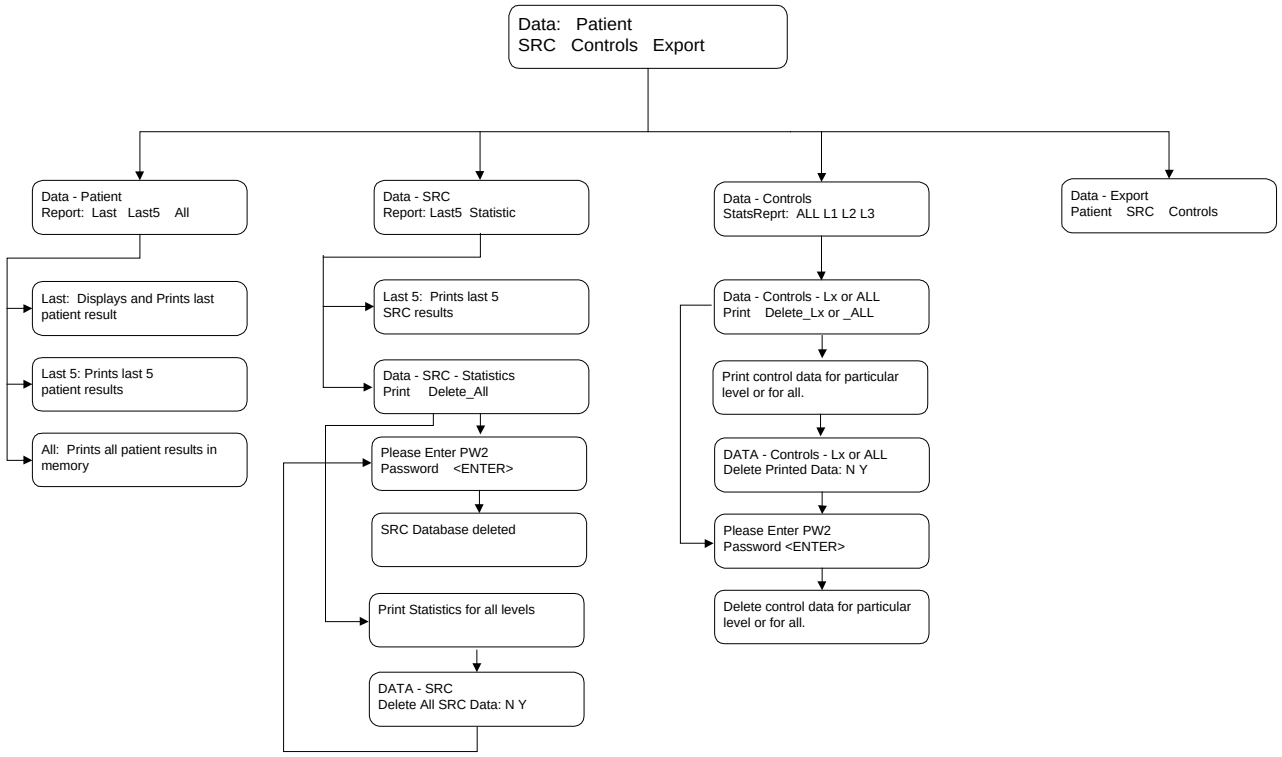


Fig. 2-14: Data Menu

Setup Menu – OPTI CCA

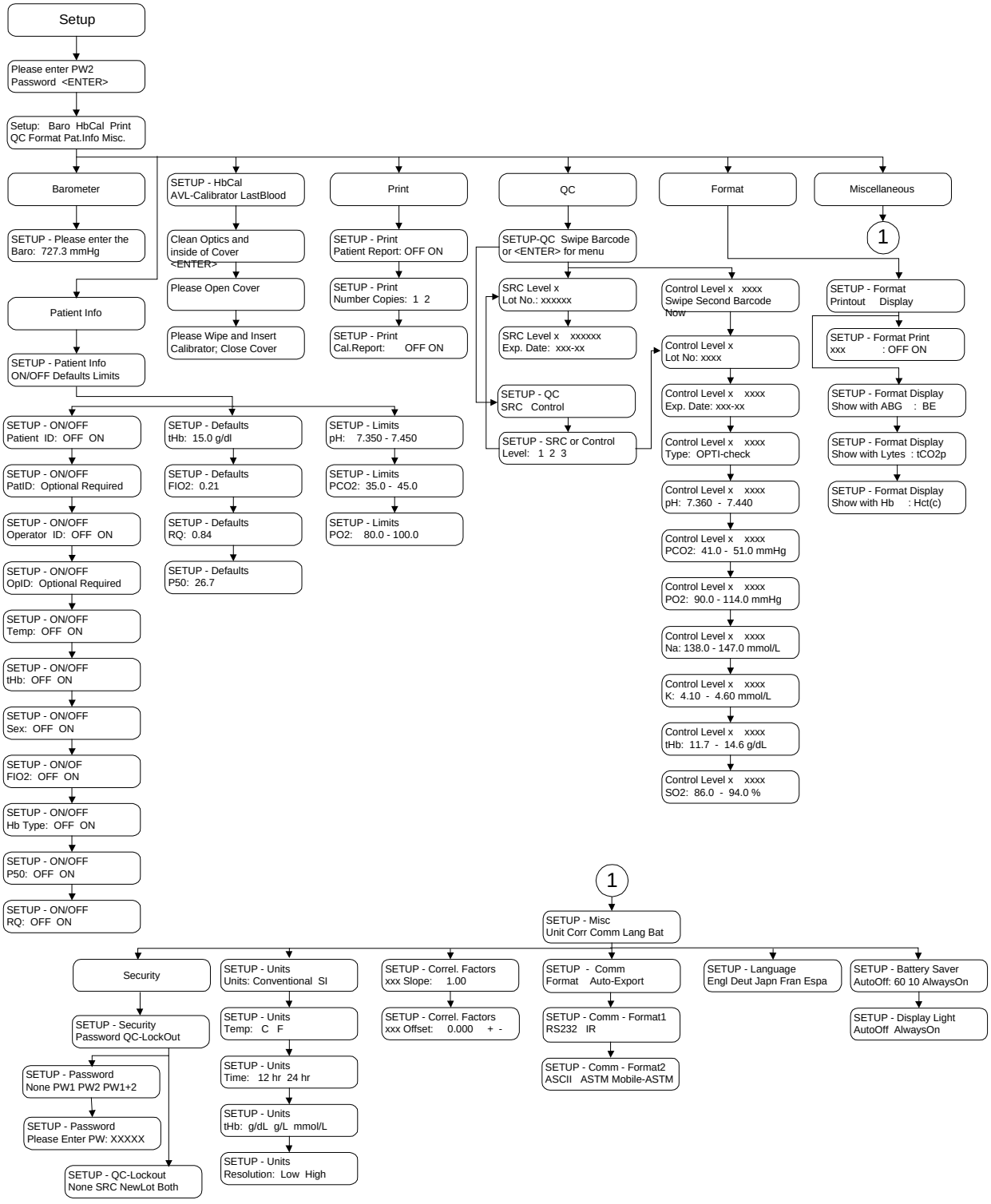


Fig. 2-15: Setup Menu

Diagnostic Menu – OPTI CCA

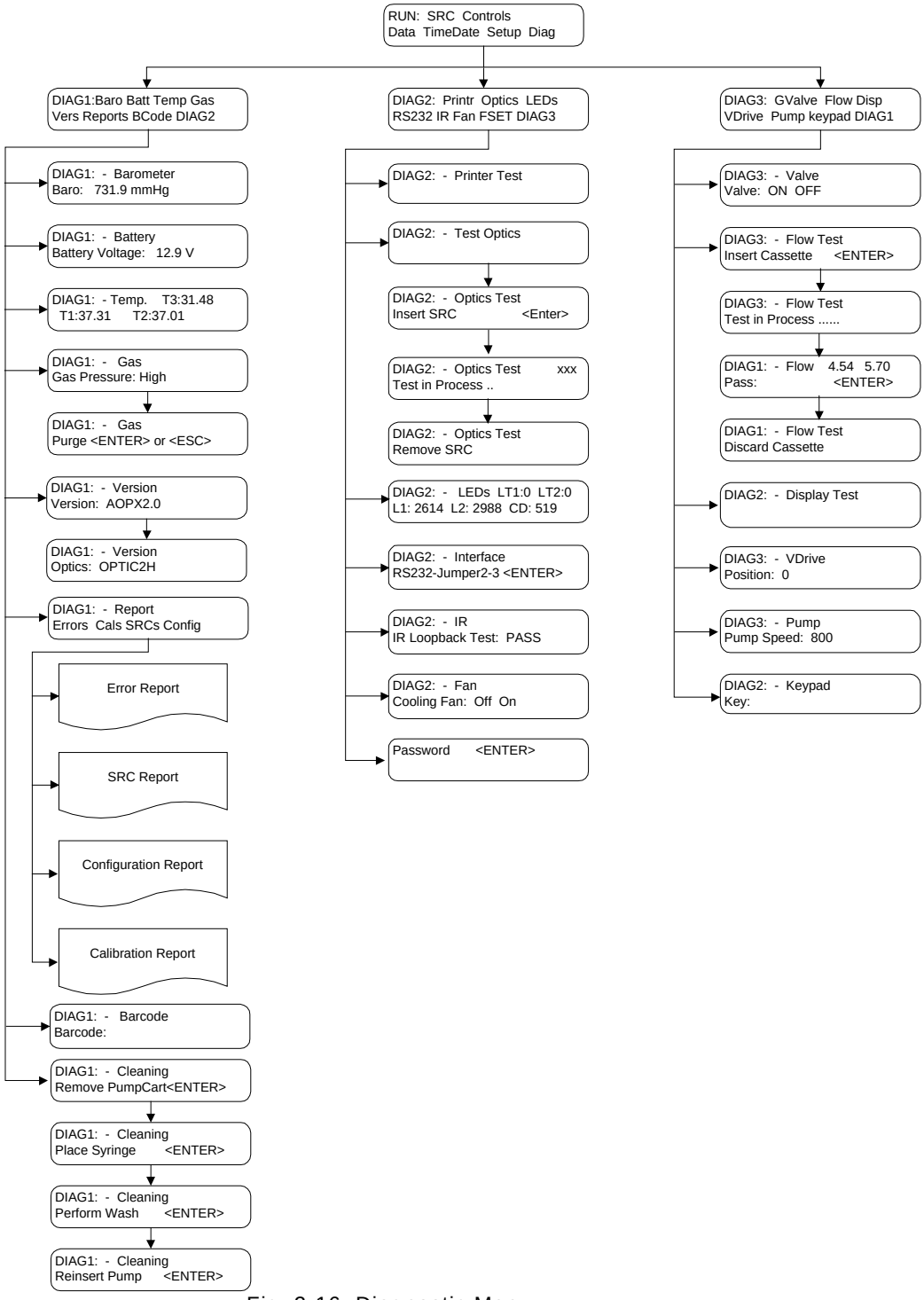


Fig. 2-16: Diagnostic Menu

QC Range Setup Menu – OPTI CCA

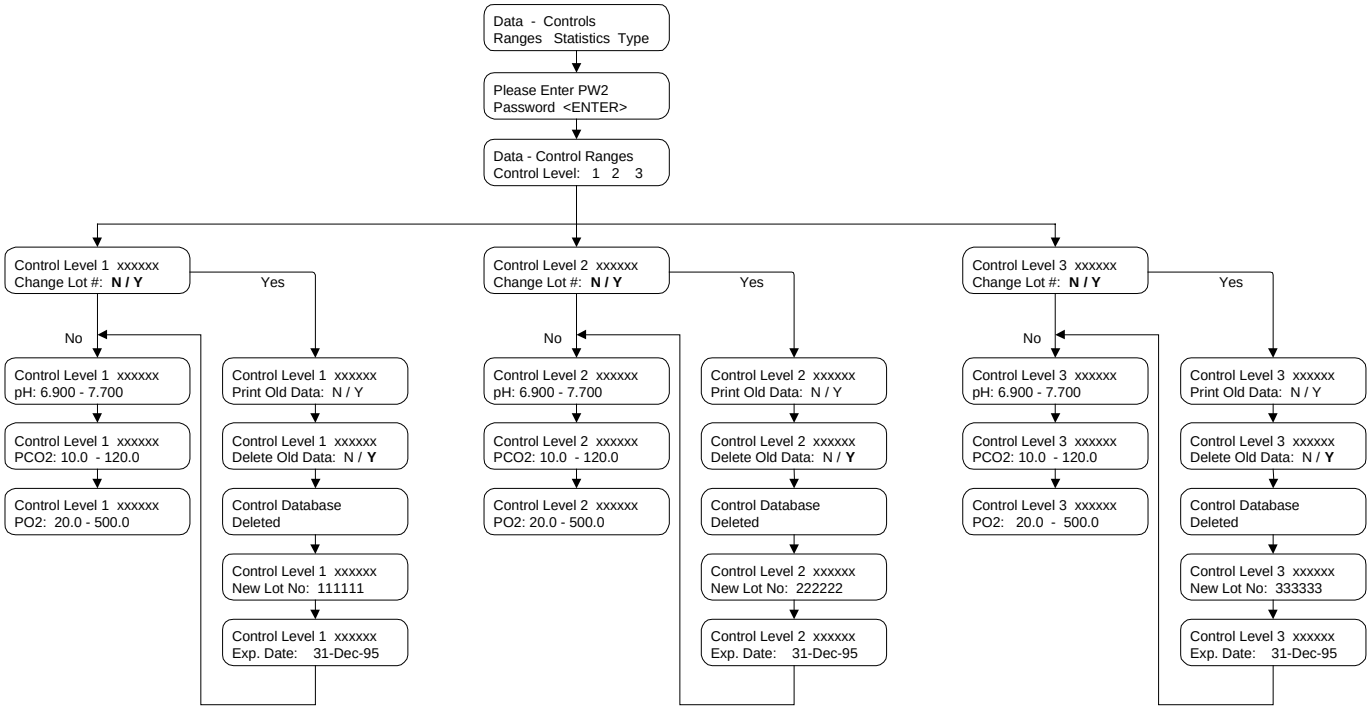


Fig. 2-17: QC-Range Setup Menu

3 Installation and Maintenance

OPTI 1 System

Environment

Location is important for trouble-free operation of your analyzer. Before beginning setup of the analyzer, choose a location that provides a stable flat surface and meets the following environmental requirements for the unit:

- Grounded electrical outlet if operated with optional power supply.
- Away from direct sunlight.
- Room temperature between 15 °C and 32 °C (59 - 90 °F).
- Maximum relative humidity of 95% non-condensing.
- Sufficient space to allow air to circulate around the unit.
- Away from strong electromagnetic fields, such as those created by electric motors and X-ray equipment.
- Away from explosive gases or vapors.
- Secure and level work surface.

Note: Above requirements also apply when the OPTI 1 Analyzer operates on battery power outside a laboratory setting.

Before beginning installation of the analyzer, check the contents to ensure that the required accessories have been included and are free from shipping damage. Check for these items which are necessary to complete the installation of the OPTI 1 system:

- Power Cord
- Battery Pack
- OPTI 1 Cassette Packs
- Blood Gas Controls
- Gas Cylinder
- 2 Standard Reference Cassettes (SRC)
- Power Supply (Battery Charger)
- Thermal Printer Paper
- Peristaltic Pump Cartridge
- Capillary Tubes

Analyzer Installation

Begin by placing the analyzer on a secure table top that allows sufficient work space and is near an electrical power outlet.

1. Plug in the Battery Charger

- Plug the battery charger power cord into the receptacle on the left rear side of the analyzer.
- Plug the power cord into a grounded electrical outlet.

2. Install the battery pack in the battery receptacle

- Push the battery pack into the receptacle on the left hand side of the OPTI 1.

Note: The battery will need to be charged for at least 6 hours prior to use without the AC Adapter. It will be charged automatically whenever the analyzer is plugged into an electrical outlet.

3. Turn on the Power

- Locate and turn on the power switch on the left side of the analyzer.

The AVL OPTI 1 Analyzer will now begin warming up. During this time keypad entries can be made to configure the analyzer settings.

- Use the numeric keys to make changes to the information on the display.
- Use the J key to accept the displayed values or information.
- The arrow keys, l and r are used to move the cursor and select menus.
- The E key returns you to the previous software level.

4. Install the Gas Cylinder

- Remove the protective cap on the gas cylinder.
- Swipe the barcode of the gas bottle.
- Insert the cylinder into the gas receptacle located on the right hand side of the analyzer.
- Turn clockwise (to the right) until ‘finger’ tight. Be sure the tank fits tightly to avoid any gas leaks.

Note: A wrench is not needed to tighten the gas cylinder. The low pressure seal is made with an O-ring.

5. Install the Printer Paper

- Place paper into the paper tray.
- Thread the paper into the paper feed slot, as shown in the diagram on the analyzer.
- Press the paper advance button to bring the paper completely through the feeder.

6. Enter Date and Time

- Move the cursor to the correct position (with arrow key).
- Enter correct date, press J .
- Follow the same procedure to enter the correct time, then use the arrow key to make **AM** or **PM** blinking, press J

  Note: The Date and Time need only be entered when the system is installed.

The system purges the gas system for approximately one minute.

The system will complete its warm-up.

Once the warm-up is complete, the analyzer is ready for sample analysis.

Prior to analyzing patient samples or Quality Control materials, a complete check should be performed. In addition, run the Standard Reference Cassettes (SRC's) to validate system performance. Refer to Chapter 4, Sec 4.5.1 "Running an SRC Measurement" of the Operator's Manual for instructions.

Maintenance

The OPTI 1 analyzer requires minimal routine operator maintenance to provide trouble-free operation. The routine maintenance required is described in this section.

Daily Maintenance

No daily maintenance is required for the OPTI 1 analyzer.

Weekly Maintenance

Once per week, the Sample Measurement Chamber (SMC) must be cleaned. Open the top cover and clean the optics surfaces with a lint-free cloth, slightly moistened with a dilute alcohol or ammonia-based cleaner as needed. Make sure to remove any blood residue. Use a cotton swab for cleaning cramped or restricted areas such as near the valve drive.

Annual Maintenance

Once a year, the peristaltic pump cartridge needs to be replaced.

As Needed Maintenance

The gas cylinder is designed to provide up to 200 sample measurements. The analyzer provides a display message to inform the user when it is necessary to change the gas cylinder.

The thermal printer paper supplied with the OPTI 1 includes an indicator strip to alert the user when the paper roll needs to be replaced.

Clean the outside housing surfaces of the OPTI 1 using a soft damp cloth as necessary to preserve the appearance of the analyzer.

Note: Never use strong chemical or abrasive cleaners on the OPTI 1 to avoid damage to the housing surfaces.

4 Mechanics

OPTI System

The AVL OPTI is completely housed in a molded plastic case, which provides a chassis for the electronic and mechanical assemblies. The analyzer is designed for quick removal of all major assemblies. Some of the components such as the printer, pump cartridge and top plate are accessible from the outside of the analyzer. The analyzer interior is accessible, after removing the bottom of the analyzer. The following chapter describes the removal of the major assemblies of the OPTI analyzer.

Caution: Before disconnecting any analyzer assemblies, disconnect the analyzer from primary power and remove the installed battery to avoid electrical damage or electrical shock.

Pump Cartridge

The pump cartridge can be removed easily. Open the printer compartment cover to access the pump cartridge. Grasp the pump cartridge and pull straight up to free it from the pump motor shaft.

To reinstall the pump cartridge, first check whether the flat in the pump spool is aligned with the flat on the pump motor shaft. If the flat on the pump spool is not aligned, a coin can be used to turn the spool within the pump cartridge housing and align the pump spool with the motor shaft. The motor shaft may also be turned for easier reinstallation of the pump cartridge. For easiest alignment of the motor shaft, turn the motor shaft so the flat on the motor shaft is parallel to the right side of the analyzer housing with motor shaft flat to the right. Insert the pump cartridge and press down with a slight force so the cartridge fits onto the motor shaft and ensure the cartridge is seated into the pump ports. Press down on the pump spool to prevent the pump roller from binding on the pump cartridge housing.

Printer Assembly

To remove the printer assembly, first open the printer cover to gain access to the printer assembly. First remove the pump cartridge to allow enough free space for removing the printer assembly without interference in the printer compartment. The pump cartridge can be removed by grasping it and pulling it up. Next remove the printer paper and set aside. Two thumbscrews that hold the printer assembly in place can now be loosened. After the thumbscrews have been loosened, the printer can be slid towards the rear of the analyzer. Disconnect the printer ribbon cable that attaches to the printer. The printer assembly can now be removed.

Analyzer Housing

The main analyzer housing is comprised of two parts, the lower and upper housing. The assemblies located inside the analyzer can be removed. To gain access to these assemblies, the analyzer housings must be separated. To open the analyzer housing, first remove the battery on the left side of the analyzer. Turn the analyzer over to access the seven (7) screws securing the two housing sections together. Remove the screws and separate the upper and lower housing sections.

Caution: When turning the analyzer over to access the lower housing section, place the analyzer on a padded surface to prevent scratches or other damage to the upper housing section.

Sample Measurement Chamber Cover

To remove the SMC cover, the bottom of the analyzer must first be opened to separate the top and bottom portions of the analyzer housing. Locate the cable and disconnect the cable from the main board. Open the top cover of the SMC and remove the two (2) screws at the cover hinge. Next remove the hinge plate. Then pull the cover to remove it. The cable will be attached to the SMC cover. For reinstallation follow the above steps in reverse order.

Note: The OPTI CCA SMC Cover is not field replaceable. The complete unit must be returned the local service repair facility.

SMC Lower Module

The SMC top cover must first be removed. Disconnect the cables for the valve drive motor, sample light gates and optics. Next remove the tygon tubing from the peristaltic pump port. For easier access, remove the battery housing and the gas module. Three (3) screws hold the module in place. Pull out the module from the bottom of the analyzer. For reinstallation follow the above steps in reverse order. Spare SMC modules are delivered with a calibration sheet. Upon installation of the new SMC module, the values indicated on the calibration sheet have to be programmed into the instrument using the **Fset** menu (see Chapter 6 - **Fset**).

OPTI Handle

The OPTI is equipped with a carrying handle for easy transport. To remove the handle, first separate the lower portion of the analyzer. To access the handle, remove the battery compartment, gas manifold module and storage compartment. Next remove the four (4) self-tapping screws which hold the handle in place.

Gas Manifold Module

The gas manifold module is located on the right rear side of the analyzer. The calibration gas cylinder is screwed into the module to form a gas-tight seal. The gas manifold module provides pressure regulation and controls the flow of gas when required for cassette calibration. To remove the module, first open the lower portion of the analyzer. Disconnect the tygon tubes, which connect to the peristaltic pump and clean-out port. Next disconnect the cable connector on the Main Board. There are two (2) retaining screws that hold the module in place. After removal of these screws, the module may be pulled out of the analyzer. Upon reassembly, make sure the tubes from the clean-out port and the peristaltic pump are connected to the correct nipples. The tubes should *not* be crossed.

There are two types of gas manifolds. The older type is marked with a red dot, the newer type with a green dot (do not confuse the dot with the calibration label which is white or green and contains a 3-digit number). After installation, the correct type - red or green - must be programmed into the instrument, using the **Fset** menu (see Chapter 6 **Fset**).

Display Assembly

The OPTI uses a backlit LCD display module to display operating instructions and analyzer results. To remove the LCD display, first open the lower portion of the analyzer and disconnect the ribbon cable on the main board. The storage compartment and gas manifold module must also be removed. Next remove the four (4) screws which hold the LCD display assembly in place. The assembly can now be removed. To reinstall the assembly, follow the removal instructions in reverse order. Before tightening the mounting screws, make sure to center the display over the window.

Keypad

The keypad fitted on the OPTI can be removed by first opening the lower portion of the analyzer. The flex cable from the keypad will now need to be disconnected from the display board. Use a knife to lift off the keypad from the analyzer housing. Before replacement with a new keypad, the surface must be cleaned. Use alcohol to remove any adhesive, which may be on the surface. The surface must be clean and dry before installing a new keypad. Take the new replacement keypad and remove the backing to expose the adhesive side of the keypad. Carefully apply the new keypad to ensure proper alignment on the analyzer housing.

Caution: The keypad is attached to the housing of the analyzer with an adhesive backing and can not be re-used once removed from the analyzer.

Exhaust Fan

The OPTI is equipped with an internal exhaust fan, which is used for cooling the electronic circuitry. To remove the fan, first open the lower portion of the analyzer. Disconnect connector that attaches to the main board. One (1) screw fastens to the fan retainer and must be removed. Next remove the retainer and slide the fan out of the analyzer.
The software controls the fan. T3 measures the air temperature inside the OPTI housing and is displayed in the **DIAG1 - Temp** menu. If T3 rises above 31.5 ° C, the fan is activated. The fan turns off, when T3 drops below 30.5 ° C.

Storage Compartment

Located on the rear panel of the OPTI is a storage compartment. The storage compartment is included to provide a convenient location for storing small accessories during transport of the analyzer. To disassemble the storage compartment, first separate the lower portion of the analyzer. Then, slide the storage compartment out of the upper housing. To replace the storage compartment, fit the grooved edges of the compartment over the upper housing and slide it into place.

Peristaltic Pump Motor

The peristaltic pump assembly is comprised of the pump motor and the peristaltic pump cartridge and during operation provides the necessary pump flow to move reagents and samples into the OPTI. The peristaltic pump uses a stepper motor, which is controlled by the main board and turns the pump roller in the pump cartridge to generate a small vacuum. To remove the pump motor, open the lower portion of the analyzer housing for access to the assembly. Remove the pump cartridge and disconnect the pump motor cable from the main board. Locate the pump motor and remove the four (4) mounting screws. The motor may now be removed. For reinstallation, reverse above steps.

Battery Receptacle

The OPTI can be operated by either battery power or by connection to a supplied battery charger unit connected to AC main power. The battery can easily be exchanged with a fully charged battery as described in the Operator's Manual. To remove the battery receptacle, first remove the battery from the analyzer. The lower housing portion of the analyzer must be opened for access. Locate the battery receptacle and disconnect the internal cable from the main board. Next remove the two (2) retaining screws and pull the receptacle out of the analyzer.

Main Board Assembly

The OPTI analyzer is controlled and powered by the main board assembly. This board contains the microprocessor and associated control circuitry. Interconnections for the major assemblies are by cables attached directly to the board. For board removal first open the lower portion of the analyzer housing to access the board. Disconnect all the cables attached to the board. Remove the two (2) retaining screws that secure the board to the lower portion of the analyzer housing and pull out the circuit board. Located on the back of the main board are two (2) EPROM's which can also be replaced in the event of failure or software revision. It is not necessary to separate the analyzer housing to access these EPROM's. The OPTI analyzer has been designed and is equipped with an EPROM cover located on the bottom of the analyzer. Remove the cover to access the EPROM's. A special EPROM carrier can be used for easy installation and removal of the EPROM's. This special carrier allows for customer replacement of the EPROM's. To remove the EPROM's after opening the EPROM cover, insert a coin under the tabs of the carrier and pry out the EPROM's. Replacement EPROM's are supplied with the EPROM carrier for easy installation.

Caution: Always disconnect power and remove the battery before handling electronic assemblies. When replacing the main board, perform the adjustment procedures outlined in Section 7 of this manual before returning to operation.

To reset the OPTI software after installing new software or in the event of system corruption, open the cover, hold in the paper advance button and cycle the main power.

Caution: When the OPTI software is reset, all patient results, QC data, SRC data and setup parameters stored in system memory will be lost.

To replace the main board, separate the lower housing from the upper housing by removing 7 screws. Next, disconnect all cables from the main board. For easy access, place the OPTI upside down on a work surface. Then, flip the lower housing over the handle. After all cables have been disconnected, remove the lower housing. Remove the two screws that hold the main board in place and install the new board in reverse order. The EEPROM on the main board holds all factory settings for the OPTI. To avoid reprogramming all these values, install EEPROM from the old board onto the new board. As an alternate method, record all **Fset** values (see Chapter 6 - **Fset**) *prior* to removal of the old board and reprogram the values after installing the new board.

Note: The OPTI CCA Main Board is not field replaceable. The complete unit must be returned the local service repair facility.

Barcode Reader

The internal barcode reader assembly is used to read the barcode data supplied with each cassette and Standard Reference Cassette (SRC). To access the internal barcode reader, first separate the upper and lower analyzer housing sections. Locate the barcode reader guide. Push on the latch and slide the guide downward. The module is held in place by retaining screws, which must be removed. Disconnect cable from the main board. Pry out the window of the barcode reader with a screwdriver.

5 Electronic Description

OPTI 1 Main Board

The AVL OPTI 1 Main Board consists of the following electronic circuits.
The schematic diagram for each part of the electronic description is located in Section 9 and is referenced to a sheet number corresponding to the electronic descriptions found in this section.

SYSTEM FUNCTIONAL BLOCK DIAGRAM SHEET 1

CIRCUIT DIAGRAM SHEET 2
Component Location

CIRCUIT DIAGRAM SHEET 3
Real Time Clock
RAM Battery Back-up
Address Decoder

CIRCUIT DIAGRAM SHEET 4
Microprocessor
Clock

CIRCUIT DIAGRAM SHEET 5
16 Bit EPROM

CIRCUIT DIAGRAM SHEET 6
16 Bit RAM

CIRCUIT DIAGRAM SHEET 7
RS232 Controller
Barcode Controller
Buzzer

CIRCUIT DIAGRAM SHEET 8
Keypad Controller
Keypad Decoder
Parallel Display Register

CIRCUIT DIAGRAM SHEET 9
Status LED Driver
Cassette Detection
Motor Drive Detection
Gas Pressure Input
7 Stage Ripple Counter

CIRCUIT DIAGRAM SHEET 10
Input Power and Power Switch
Main Power Fuse F1
Battery Charge Controller
Battery Status LED

OPTI 1 Main Board
Continued

CIRCUIT DIAGRAM SHEET 11
Fuses F2 and F3
Switching +5 Volt Regulator
+ 5 Volt Regulator
+ 12 Volt Regulator
Positive to Negative Voltage Converter
- 5 Volt Regulator
SSMC Heater Supply

CIRCUIT DIAGRAM SHEET 12
+5 Volt Reference Voltage Regulator
SSMC Temperature Controller

CIRCUIT DIAGRAM SHEET 13
SSMC Heater Drivers

CIRCUIT DIAGRAM SHEET 14
SMC Bottom Plate NTC
SMC Top Plate NTC
Battery Back-up Reference

CIRCUIT DIAGRAM SHEET 15
Sample Sensor LED D/A Controllers
Barometric Pressure Reference Voltage

CIRCUIT DIAGRAM SHEET 16
A/D Converter

CIRCUIT DIAGRAM SHEET 17
Barometric Pressure Converter

CIRCUIT DIAGRAM SHEET 18
Peristaltic Pump Controller Driver
Valve Drive Motor Driver
Gas Valve Driver

CIRCUIT DIAGRAM SHEET 19
Printer Motor Controller Driver
Printer Serial to Parallel Converter

CIRCUIT DIAGRAM SHEET 20
Cassette Detection

CIRCUIT DIAGRAM SHEET 21
Connectors to Assemblies

Main Board - Circuit Diagram Sheet 1

The Main Board circuitry is divided into 20 separate circuit schematic diagrams. The division of the circuit schematic is done to facilitate component identification and signal tracing. Each diagram contains signal labels allowing service personnel to trace signals throughout the board. Located near the signal labels are small case numbers. These numbers identify the circuit sheet where the signal is connected.

Main Board - Circuit Diagram Sheet 2

This diagram shows the component location on the main board.

Main Board - Circuit Diagram Sheet 3

IC U41, a non-volatile controller, detects analyzer power supplied either by the internal battery system or the external power source. In the event of a loss of power, U41 switches to provide RAM battery backup from battery BT1.

IC U38 is a real-time clock and provides time and date information used within the AVL OPTI 1. Crystal Y3 is connected to IC U38 to provide a constant operating frequency and control of the real-time clock.

IC U19 and U13 are 2 of 8 decoders providing various signal outputs as labeled on the right side of the schematic diagram. These two decoders utilize signals PCS0 through PCS3 as a control signal to decode 14 outputs, as two outputs are not used.

Main Board - Circuit Diagram Sheet 4

A 132 pin MOTOROLA MC68372 microprocessor, U24, controls the AVL OPTI 1. Crystal Y2 is connected directly to the microprocessor to provide a stable frequency control to the microprocessor. U54B, a quad gate is also connected to the crystal and is used as a buffer to provide a 32KHz signal to other portions of the electronic circuitry. U30 is an in-line buffer used to buffer some of the microprocessor inputs.

Main Board - Circuit Diagram Sheet 5

U9 and U10 are 512K by 8 EPROMS and together comprise a 16-bit data bus used by the OPTI 1. The user fits these two EPROMS to the main board in a special socket, which allows for easy removal of the EPROMS to allow software replacement.

U8 is a serial 128 by 16 Serial EEPROM that stores instrument specific data.

Main Board - Circuit Diagram Sheet 6

The circuitry on this sheet, IC's U7 and U11 are 128K by 8 RAM chips that together provide a 16 bit data byte.

Main Board - Circuit Diagram Sheet 7

IC U3 is a Dual RS232 Driver and provides the serial interface control within the OPTI 1. Connected to U3 and mounted to the Main Board is P1, a standard 9-pin D-type connector.

U5 is a barcode controller. The barcode controller is connected to the internal barcode reader through J14 and an optional external barcode wand which can be connected through J2, a RJ45 type connector mounted on the main board. The barcode input from either barcode device is fed to pin 8 of U5 and an 8-bit data output is buffered by U6.

BZ1 driven by transistor Q8 is a piezo speaker and provides an audible alarm when activated.

Main Board - Circuit Diagram Sheet 8

Plug J13 provides input from the Keypad and is fed to U49, an 8 bit serial input latch, which decodes the selected keypad entries. The serial output is buffered and fed directly to the microprocessor. U40A and U40B are dual D Flip-Flops, which provide input to U51, one of eight decoders. U51 is fed to U49 to determine the correct keypad row. U48A, B, C are part of a quad AND Gate package and provide debounce circuitry for the keypad.

Serial data from the microprocessor is fed to the input of U50, a serial 8-bit shift register to convert the serial display data to parallel data. The parallel data is connected to the display through J13.

Main Board - Circuit Diagram Sheet 9

Serial data from the microprocessor is fed to U53, an 8-bit serial to parallel shift register. This data provides the logic to control cassette detection LED's and provides output signals to the status LED. U44 is a seven-stage ripple counter used to divide the 32 kHz clock to a frequency of 1024 Hz. This divided clock and data from U53 are fed to AND Gate U54A. This output provides the signal to drive the cassette light gates.

U52 is a parallel load to serial 8-bit shift register, which receives input from the cassette light gates and other signals and provides serial data to the microprocessor.

Main Board - Circuit Diagram Sheet 10

Switch S1 is the main power switch and switches power to the OPTI 1 circuitry. Relay K1 is used to switch input power either from the internal battery or main external power supply. K2 is shown in the battery mode. When input power is supplied by the external power supply, fuse F1 provides overcurrent protection for the input power.

U1 is a +5 Volt voltage regulator used to provide a regulated voltage supply to operate U2. IC U2 is a battery charge controller with LED D46 indicating the battery charge status. When D46 is solidly on, the battery is being charged and as the battery is fully charged, D46 will blink rapidly to indicate the charge status. If D46 blinks slowly, it indicates a defective battery or the battery temperature range has been exceeded. A thermistor is included in the internal battery pack to provide temperature input to the battery charge controller.

Main Board - Circuit Diagram Sheet 11

Switched power, either from the external power supply or internal battery is fed to this circuit and is fused by F2 and F3. The +12 or +16 volts (battery/external power supply) is fed to Q4, a Darlington Pair, which provides supply voltage used to heat the sample measurement chamber (SMC). This input voltage is also fed to U12 a switching 5-Volt regulator, which supplies +5 volt power to the digital circuitry (ssv) and printer (pvcc).

U14 is a +12V voltage regulator and feeds U20, a positive to negative voltage converter. The negative voltage output from U20 is fed to U25 to provide a regulated -5 volt output. An additional +5V voltage regulator U21 is also used.

Main Board - Circuit Diagram Sheet 12

The SMC temperature circuitry comprises two temperature control circuits that control the top plate heater and the optics module heater (lower plate). U26, a +5 volt regulator, provides a reference voltage used by both circuits. Operational amplifier U33D along with potentiometer R97 and R95 provide adjustment and control for both heater circuits. IC U32A and U32B provide the optic module heater control while U32C and U32D control the top plate heater.

Main Board - Circuit Diagram Sheet 13

This circuitry with inputs from sheet 11 controls the heater transistors in the SMC assembly. U34D and U43C are connected to the base and emitter of the optics module heater transistors. The signal OPTICCTRL (from sheet 11) causes the optics module heater transistors to conduct more when the temperature of the optics module needs to be increased to maintain regulation. IC U43A operates similarly as U34D and is connected to the top plate heater transistor.

Main Board - Circuit Diagram Sheet 14

This circuit converts resistance provided by the NTC's to a voltage for the temperature control of the top and bottom plate heaters located in the SMC. Op Amp U33A is fed an input from the NTC located in the optics module heater (bottom plate), an output voltage representative of the input NTC resistance. U33C is an identical circuit and receives the NTC input from the top plate NTC. U33B is fed the reference voltage input and provides the battery backup reference voltage (signal BCHRG2) which is fed to the battery charge controller located on sheet 1.

Main Board - Circuit Diagram Sheet 15

The two digital to analog converters (DAC's) U17 and U23 control the sample sensor brightness or intensity for the sample sensor LED's, LG1 and LG2 located in the SMC assembly. A comparison is made with the values stored in memory and provides a self-calibration. This signal is fed to each sample sensor anode, which controls the intensity of the sample sensor LED's. The reference voltage signal is fed to IC U22B, which changes the impedance for the barometer circuit located on sheet 16.

Main Board - Circuit Diagram Sheet 16

The analog to digital converter U15 receives a parallel input of 8 analog signals and converts these voltages to a serial digital signal which is fed directly to the microprocessor via signal HIS0. The parallel input signals, which are labeled on the schematic, can be observed on the analyzer display when the diagnostic menu is selected.

Main Board - Circuit Diagram Sheet 17

The internal barometer circuitry is comprised of the pressure transducer (BARO1) and the associated circuitry. The output voltage of BARO1 changes according to the changing atmospheric pressure. Op Amps U16 A, B, and C are used to calibrate the output pressure and correlate this pressure to barometric pressure standard. The output voltage at TP 15 represents barometric pressure in mmHg according to the following formula:

$$\frac{\text{Voltage} + 3000}{10} = \text{BP mmHg}$$

For calibration and adjustment use the procedure in Section 7, Adjustments.

Main Board - Circuit Diagram Sheet 18

The valves and stepper motors used in the OPTI 1 analyzer are controlled by the circuitry contained on this schematic sheet. U47, a serial to parallel latch, receives input from the microprocessor and provides the control signal for the gas valve along with other signals as labeled. U28 is a serial to parallel decoder which decodes the direction and enable signal for the valve drive, peristaltic pump and the printer. U36 is the driver for the valve drive motor and is fed signals directly from the microprocessor (TP0 - TP3) and an enable signal from U28 to provide four motor drive signals to valve drive stepper motor. The peristaltic pump is controlled by U27, a stepper motor controller, which feeds U35, the driver for the peristaltic pump stepper motor.

Main Board - Circuit Diagram Sheet 19

The internal printer is controlled by this circuitry. U45, a serial to parallel printer driver, receives an enable signal and converts serial data from the microprocessor to a parallel output which is fed to the printer print heads. The printer motor is controlled and driven by U31 and U42. U31, the printer controller receives an enable and direction signal which feeds U42, the motor driver for the printer stepper motor.

Main Board - Circuit Diagram Sheet 20

The cassette detection infrared LED is monitored by U29 C and D and associated circuitry. The signal from the cassette light gate is fed to U29D and further converted by U29C. The resultant output is fed to the analog to digital converter on sheet 15 which indicates whether a cassette is in place.

Main Board - Circuit Diagram Sheet 21

This section of the main board circuitry provides signal identification for the connectors and interconnection to the other assemblies within the OPTI 1 analyzer. Also located on this schematic section is relay K2. Relay K2 is switched dependent on whether full windings or half windings are required for the peristaltic pump motor.

Main Board - TEST Points

Test Point	Circuit Sheet	Measurement	Description
TP1	10	+5.00 ±0.25 V	Regulated + 5 Volt
TP2	10	0.00 ±0.02 V	Ground
TP3	10	N/A	
TP4	11	+5.00 ±0.2 V	Regulated + 5 Volt (VCC)
TP5	10	N/A	
TP6	10	N/A	
TP7	17	-3.419 ±0.020 V	Barometer Reference Voltage
TP8	17	+5.000 ±0.005 V	Precision Reference Voltage
TP9	15	N/A	
TP10	11	N/A	SMC Heater Supply Voltage (VHTR)
TP11	11	N/A	Over Temperature
TP12	11	N/A	Unregulated Supply Voltage (VS)
TP13	16	N/A	
TP14	16	N/A	
TP15	17	Ref. Formula	Barometer Voltage Output
TP16	11	+5.00 ±0.20 V	Regulated + 5 Volt (+5V)
TP17	17	N/A	
TP18	15	N/A	
TP19	11	-5.00 ±0.20 V	Regulated - 5 Volt (-5V)
TP20	16	N/A	
TP21	16	N/A	
TP22	12	+5.000 V ± .005 V	Precision +5 volt reference voltage
TP23	12	N/A	
TP24	18	N/A	
TP25	12	N/A	
TP26	12	N/A	
TP27	12	N/A	
TP28	10	N/A	

Main Board Connectors

J1 Main Input Power

Pin	Signal Description	Schematic Sheet Location
1	Positive Voltage from External Power Supply/Charger	Sheet 10
2	Ground	Sheet 10
3	Sleeve (Ground)	Sheet 10

J2 External Barcode (RJ45)

Pin	Signal Description	Schematic Sheet Location
1	NC	Sheet 7
2	Shield (Connected to ground)	Sheet 7
3	Ground	Sheet 7
4	Supply Voltage	Sheet 7
5		Sheet 7
6		Sheet 7
7	NC	Sheet 7
8	NC	Sheet 7

J3 Debug Connector

Pin	Signal Description	Schematic Sheet Location
1	Not Used	Sheet 4
2		
3		
4		
5		
6		
7		
8		

J4 Battery Connector

Pin	Signal Description	Schematic Sheet Location
1	Battery Positive	Sheet 10
2	NC	Sheet 10
3	Battery Thermistor	Sheet 10
4	Battery Negative	Sheet 10

J5 Upgrade Board Connector

Pin	Signal Description	Schematic Sheet Location
1		Sheet 4
2	Ground	Sheet 4
3		Sheet 3, 4
4	Ground	Sheet 4
5		Sheet 4
6	Ground	Sheet 4
7		Sheet 4
8	Supply Voltage	Sheet 4
9		Sheet 3
10	Ground	Sheet 4
11		Sheet 3
12	Ground	Sheet 4
13	Supply Voltage	Sheet 4
14	+5 Volts	Sheet 4
15	-5 Volts	Sheet 4
16	Ground	Sheet 4
17	NC	Sheet 4
18	NC	Sheet 4
19	NC	Sheet 4
20	NC	Sheet 4

J6 Printer Connector

Pin	Signal Description	Schematic Sheet Location
1	Print Head 1	Sheet 11
2	Print Head 2	Sheet 11
3	Print Head 3	Sheet 11
4	Print Head 4	Sheet 11
5	Print Head 5	Sheet 11
6	Print Head 6	Sheet 11
7	Print Head 7	Sheet 11
8	Print Head 8	Sheet 11
9	Printer Supply Voltage PVcc	Bus
10	Printer Supply Voltage PVcc	Bus
11	Printer Supply Voltage PVcc	Bus
12	Printer Home Position	Sheet 4
13	Ground	Sheet 11
14	Motor Drive 4	Sheet 11
15	Motor Drive 2	Sheet 11
16	Motor Drive 1	Sheet 11
17	Motor Drive 4	Sheet 11
18	HRA	Sheet 9
19	Supply Voltage Vcc	Bus
20	HRC	Sheet 9
21	NC	Sheet 11
22	NC	Sheet 11
23	NC	Sheet 11
24	Keyboard Row	Sheet 8, 9
25	NC	Sheet 11
26	Keyboard Column	Sheet 8

J7 SMC Top Plate

Pin	Signal Description	Schematic Sheet Location
1	Top Plate Heat Transistor Emitter 1	Sheet 13
2	Heater Supply Voltage	Sheet 11
3	Top Plate Heat Transistor Base	Sheet 13
4	Top Plate NTC 1	Sheet 12, 14
5	Top Plate NTC 2	Sheet 12
6	Top Plate Heat Transistor Emitter 2	Sheet 13
7	NC	
8	NC	
9	NC	
10	Heater Supply Voltage	Sheet 11
11	Cassette Front Anode	Sheet 9
12	Cassette Rear Anode	Sheet 9
13	Cassette Front Collector	Sheet 9
14	Cassette Rear Collector	Sheet 9
15	Sense Rear Anode	Sheet 15
16	Sense Front Anode	Sheet 15
17	Sense Rear Collector	Sheet 15
18	Sense Front Collector	Sheet 15
19	Ground	Ground Bus
20	Ground	Ground Bus

J8 Optic Module Connector

Pin	Signal Description	Schematic Sheet Location
1	Supply Voltage Vcc	Bus
2	Reset	Sheet 4
3		Sheet 4
4	+5 Volts	Bus
5	- 5 Volts	Bus
6	Ground	Bus
7	Optics Transmit Data	Sheet 7
8	Optics Receive Data	Sheet 7
9	Ground	Bus
10	Ground	Bus
11	Optics Top Heater Transistor Emitter 1	Sheet 13
12	Heater Voltage Vhtr	Bus
13	Optics Top Heater Transistor Base	Sheet 13
14	Optics Top Heater Transistor Emitter 2	Sheet 13
15	Optics Block Heater Transistor Emitter 1	Sheet 13
16	Heater Voltage Vhtr	Bus
17	Optics Block Heater Transistor Base	Sheet 13
18	Optics Block Heater Transistor Emitter 2	Sheet 13
19	Optics Heater NTC 1	Sheet 12, 14
20	Optics Heater NTC 2	Sheet 12
21	N/C	
22	N/C	
23	Cassette Light Gate Driver	Sheet 9
24	Cassette Light Gate Collector	Sheet 20
25	Sense Front Emitter	Sheet 16
26	Sense Rear Emitter	Sheet 16

J9 Pump Motor Connector

Pin	Signal Description	Schematic Sheet Location
1	Pump -D	Sheet 18
2	Pump -C Relay K2	Sheet 18
3	Pump -C	Sheet 18
4	Pump -B	Sheet 18
5	Pump -B Relay K2	Sheet 18
6	Pump -A	Sheet 18

J10 Fan Control Connector

Pin	Signal Description	Schematic Sheet Location
1	+12 Volts	Bus
2	Fan Control	Sheet 18

J11 Gas Valve 1 Connector

Pin	Signal Description	Schematic Sheet Location
1	Supply Voltage Vs	Bus
2	Gas Pressure 1	Sheet 9
3	Gas Valve 1 (GV1)	Sheet 18
4	Supply Voltage Vs	Bus
5	Auxiliary	Sheet 18

J12 Sample Measurement Chamber Connector

Pin	Signal Description	Schematic Sheet Location
1	Ground	Bus
2	Ground	Bus
3	Home Position Light Gate	Sheet 9
4	SMC Light Gate	Sheet 9
5	Ground	Bus
6	Ground	Bus
7	Home Position LED	Sheet 9
8	Supply Voltage Vvss	Bus
9	NC	
10	NC	
11	Valve -D	Sheet 18
12	Valve -B	Sheet 18
13	Valve -A	Sheet 18
14	Valve -C	Sheet 18

J13 LCD / LED Connector

Pin	Signal Description	Schematic Sheet Location
1	Keypad Row A	
2	Keypad Column A	
3	Keypad Row B	
4	Keypad Column B	
5	Keypad Row C	
6	Keypad Column C	
7	Keypad Row D	
8	Keypad Column D	
9	LCD BL	Sheet 18
10	Status LED Green	Sheet 9
11	Status LED Yellow	Sheet 9
12	Status LED Red	Sheet 9
13	Ground	Bus
14	Vcc	Bus
15	Status LED Blink	Sheet 4
16	LCD Enable	
17	LCD Read Write	
18	LCD Reset	
19	LCD Data 0	
20	LCD Data 1	
21	LCD Data 2	
22	LCD Data 3	
23	LCD Data 4	
24	LCD Data 5	
25	LCD Data 6	
26	LCD Data 7	

OPTI CCA Circuits

The AVL OPTI CCA Optics Module and Main Board consist of the following electronic circuits. The schematic diagram for each part of the electronic description is located in Section 9 and is referenced to a sheet number corresponding to the electronic descriptions found in this section.

SYSTEM FUNCTIONAL BLOCK DIAGRAM SHEET 1

CIRCUIT DIAGRAM
Component Location

CIRCUIT DIAGRAM SHEET 1
Optics Module
Digital Circuit

CIRCUIT DIAGRAM SHEET 2
Optics Module
Amplifier Circuit

CIRCUIT DIAGRAM SHEET 3
Optics Module
Amplifier Circuit

CIRCUIT DIAGRAM SHEET 4
Optics Module
Inverter Circuit

CIRCUIT DIAGRAM SHEET 5
Optics Module
A/D Converter Circuit

CIRCUIT DIAGRAM SHEET 6
Optics Module
LED's, Gasses & DAC Circuit

CIRCUIT DIAGRAM SHEET 7
Optics Module
LED's and Lytes Circuit

CIRCUIT DIAGRAM SHEET 8
Optics Module
Interconnect Circuit

OPTI CCA Circuits
Continued

CIRCUIT DIAGRAM SHEET 1
Main Board
RAM Battery Backup Circuit
Clock Circuit

CIRCUIT DIAGRAM SHEET 2
Main Board
Microprocessor Circuit

CIRCUIT DIAGRAM SHEET 3
Main Board
16 Bit EPROM Circuit

CIRCUIT DIAGRAM SHEET 4
Main Board
16 Bit RAM Circuit

CIRCUIT DIAGRAM SHEET 5
Main Board
Barcode Interface Circuit

CIRCUIT DIAGRAM SHEET 6
Main Board
Keypad and Display Circuit

CIRCUIT DIAGRAM SHEET 7
Main Board
Cassette Detection Logic Circuit

CIRCUIT DIAGRAM SHEET 8
Main Board
Battery Charger Circuit

CIRCUIT DIAGRAM SHEET 9
Main Board
Voltage Regulator Circuit

CIRCUIT DIAGRAM SHEET 10
Main Board
SMC Temperature Control Circuit

OPTI CCA Circuits
Continued

CIRCUIT DIAGRAM SHEET 11
Main Board
SMC Heater Transistor Circuit

CIRCUIT DIAGRAM SHEET 12
Main Board
SMC Heater Control Circuit

CIRCUIT DIAGRAM SHEET 13
Main Board
Digital to Analog Converter Circuit

CIRCUIT DIAGRAM SHEET 14
Main Board
A/D Converter Circuit

CIRCUIT DIAGRAM SHEET 15
Main Board
Barcode Circuit

CIRCUIT DIAGRAM SHEET 16
Main Board
Motor Drive Circuit

CIRCUIT DIAGRAM SHEET 17
Main Board
Printer Controller Circuit

CIRCUIT DIAGRAM SHEET 18
Main Board
Cassette Detect Circuit

CIRCUIT DIAGRAM SHEET 19
Main Board
Interconnect Circuit

CIRCUIT DIAGRAM SHEET 20
Main Board
Serial Interface Circuit

CIRCUIT DIAGRAM SHEET 21
Main Board
tHb/SO2 Laser/LED Driver Circuit

OPTI CCA Circuits
Continued

CIRCUIT DIAGRAM SHEET 22
Main Board
tHb/SO2 Amplifier Circuit

CIRCUIT DIAGRAM SHEET 23
Main Board
Over Temperature Protection Circuit

CIRCUIT DIAGRAM SHEET 1
Optics Module
Interconnect Circuit

CIRCUIT DIAGRAM SHEET 2
Optics Module
LED's, Gasses & Heater Circuit

CIRCUIT DIAGRAM SHEET 3
Optics Module
LED's, ION & Heater Circuit

CIRCUIT DIAGRAM SHEET 1
Optics Module
SMC Heater / tHb Circuit

CIRCUIT DIAGRAM SHEET 1
Display IR Board
Interconnect Circuit

CIRCUIT DIAGRAM SHEET 2
Display IR Board
IR Circuit

Main Board - OPTI CCA
TEST Points

Test Point	Circuit Sheet	Measurement	Description
TP1	8	+5.00 ±0.25 V	Regulated + 5 Volt
TP2	8	N/A	
TP3	8	N/A	
TP4	8	N/A	
TP5	8	N/A	
TP6	14	N/A	
TP7	9	+5.00 ±0.2 V	Regulated + 5 Volt (VCC)
TP8	17	+5.000 ±0.005 V	Precision Reference Voltage
TP9	14	N/A	
TP10	14	N/A	SMC Heater Supply Voltage (VHTR)
TP11	14	N/A	Over Temperature
TP12	14	N/A	Unregulated Supply Voltage (VS)
TP13	14	N/A	
TP14	8	N/A	
TP15	8	N/A	
TP16	9	N/A	
TP17	17	N/A	
TP18	15	-3.57 ±0.020 V	Barometer Reference Voltage
TP19	13	N/A	
TP20	15	Ref. Formula	Barometer Voltage Output
TP21	15	N/A	
TP22	13	N/A	
TP23	9	N/A	
TP24	9	N/A	
TP25	9	+5.00 ±0.20 V	Regulated + 5 Volt (+5V)
TP26	12	N/A	
TP27	14	N/A	
TP28	14	N/A	
TP29	14	N/A	
TP30	14	N/A	
TP31	9	-5.00 ±0.20 V	Regulated - 5 Volt (-5V)
TP32	10	+5.000 V ± .005 V	Precision +5 volt reference voltage
TP33	10		
TP34	10		
TP35	16		
TP36	10		

Main Board - OPTI CCA
TEST Points

Test Point	Circuit Sheet	Measurement	Description
TP37	9		
TP38	8	0.00 ±0.02 V	Ground
TP39	10		
TP40	21		670 nm LED -
TP41	21		670 nm LED +
TP42	21		850 nm Laser -
TP43	21		850 nm Laser +
TP44	21		
TP45	21		780 nm Laser -
TP46	21		780 nm Laser +
TP47	23		
TP48	23		
TP49	22		
TP50	22		

Main Board Connectors

J1 External Barcode (RJ45)

Pin	Signal Description	Schematic Sheet Location
9	NC	Sheet 7
10	Shield (Connected to ground)	Sheet 7
11	Ground	Sheet 7
12	Supply Voltage	Sheet 7
13		Sheet 7
14		Sheet 7
15	NC	Sheet 7
16	NC	Sheet 7

J2 Main Input Power

Pin	Signal Description	Schematic Sheet Location
4	Positive Voltage from External Power Supply/Charger	Sheet 10
5	Ground	Sheet 10
6	Sleeve (Ground)	Sheet 10

J3 Battery Connector

Pin	Signal Description	Schematic Sheet Location
5	Battery Positive	Sheet 10
6	NC	Sheet 10
7	Battery Thermistor	Sheet 10
8	Battery Negative	Sheet 10

J4 tHb/SO2 Connector

Pin	Signal Description	Schematic Sheet Location
1		Sheet
2		Sheet

J5 IRDA Connector

Pin	Signal Description	Schematic Sheet Location
1		Sheet
2		Sheet

J6 SMC Top Plate

Pin	Signal Description	Schematic Sheet Location
21	Top Plate Heat Transistor Emitter 1	Sheet 13
22	Heater Supply Voltage	Sheet 11
23	Top Plate Heat Transistor Base	Sheet 13
24	Top Plate NTC 1	Sheet 12, 14
25	Top Plate NTC 2	Sheet 12
26	Top Plate Heat Transistor Emitter 2	Sheet 13
27	NC	
28	NC	
29	NC	
30	Heater Supply Voltage	Sheet 11
31	Cassette Front Anode	Sheet 9
32	Cassette Rear Anode	Sheet 9
33	Cassette Front Collector	Sheet 9
34	Cassette Rear Collector	Sheet 9
35	Sense Rear Anode	Sheet 15
36	Sense Front Anode	Sheet 15
37	Sense Rear Collector	Sheet 15
38	Sense Front Collector	Sheet 15
39	Ground	Ground Bus
40	Ground	Ground Bus

J7 Pump Motor Connector

Pin	Signal Description	Schematic Sheet Location
7	Pump -D	Sheet 18
8	Pump -C Relay K2	Sheet 18
9	Pump -C	Sheet 18
10	Pump -B	Sheet 18
11	Pump -B Relay K2	Sheet 18
12	Pump -A	Sheet 18

J8 Fan Control Connector

Pin	Signal Description	Schematic Sheet Location
3	+12 Volts	Bus
4	Fan Control	Sheet 18

J9 Gas Valve 1 Connector

Pin	Signal Description	Schematic Sheet Location
6	Supply Voltage Vs	Bus
7	Gas Pressure 1	Sheet 9
8	Gas Valve 1 (GV1)	Sheet 18
9	Supply Voltage Vs	Bus
10	Auxiliary	Sheet 18

J10 Sample Measurement Chamber Connector

Pin	Signal Description	Schematic Sheet Location
15	Ground	Bus
16	Ground	Bus
17	Home Position Light Gate	Sheet 9
18	SMC Light Gate	Sheet 9
19	Ground	Bus
20	Ground	Bus
21	Home Position LED	Sheet 9
22	Supply Voltage Vvss	Bus
23	NC	
24	NC	
25	Valve -D	Sheet 18
26	Valve -B	Sheet 18
27	Valve -A	Sheet 18
28	Valve -C	Sheet 18

J11 Optic Module Connector

Pin	Signal Description	Schematic Sheet Location
27	Supply Voltage Vcc	Bus
28	Reset	Sheet 4
29		Sheet 4
30	+5 Volts	Bus
31	- 5 Volts	Bus
32	Ground	Bus
33	Optics Transmit Data	Sheet 7
34	Optics Receive Data	Sheet 7
35	Ground	Bus
36	Ground	Bus
37	Optics Top Heater Transistor Emitter 1	Sheet 13
38	Heater Voltage Vhtr	Bus
39	Optics Top Heater Transistor Base	Sheet 13
40	Optics Top Heater Transistor Emitter 2	Sheet 13
41	Optics Block Heater Transistor Emitter 1	Sheet 13
42	Heater Voltage Vhtr	Bus
43	Optics Block Heater Transistor Base	Sheet 13
44	Optics Block Heater Transistor Emitter 2	Sheet 13
45	Optics Heater NTC 1	Sheet 12, 14
46	Optics Heater NTC 2	Sheet 12
47	N/C	
48	N/C	
49	Cassette Light Gate Driver	Sheet 9
50	Cassette Light Gate Collector	Sheet 20
51	Sense Front Emitter	Sheet 16
52	Sense Rear Emitter	Sheet 16

J12 Printer Connector

Pin	Signal Description	Schematic Sheet Location
27	Print Head 1	Sheet 11
28	Print Head 2	Sheet 11
29	Print Head 3	Sheet 11
30	Print Head 4	Sheet 11
31	Print Head 5	Sheet 11
32	Print Head 6	Sheet 11
33	Print Head 7	Sheet 11
34	Print Head 8	Sheet 11
35	Printer Supply Voltage PVcc	Bus
36	Printer Supply Voltage PVcc	Bus
37	Printer Supply Voltage PVcc	Bus
38	Printer Home Position	Sheet 4
39	Ground	Sheet 11
40	Motor Drive 4	Sheet 11
41	Motor Drive 2	Sheet 11
42	Motor Drive 1	Sheet 11
43	Motor Drive 4	Sheet 11
44	HRA	Sheet 9
45	Supply Voltage Vcc	Bus
46	HRC	Sheet 9
47	NC	Sheet 11
48	NC	Sheet 11
49	NC	Sheet 11
50	Keyboard Row	Sheet 8, 9
51	NC	Sheet 11
52	Keyboard Column	Sheet 8

J13 LCD / LED Connector

Pin	Signal Description	Schematic Sheet Location
27	Keypad Row A	
28	Keypad Column A	
29	Keypad Row B	
30	Keypad Column B	
31	Keypad Row C	
32	Keypad Column C	
33	Keypad Row D	
34	Keypad Column D	
35	LCD BL	Sheet 18
36	Status LED Green	Sheet 9
37	Status LED Yellow	Sheet 9
38	Status LED Red	Sheet 9
39	Ground	Bus
40	Vcc	Bus
41	Status LED Blink	Sheet 4
42	LCD Enable	
43	LCD Read Write	
44	LCD Reset	
45	LCD Data 0	
46	LCD Data 1	
47	LCD Data 2	
48	LCD Data 3	
49	LCD Data 4	
50	LCD Data 5	
51	LCD Data 6	
52	LCD Data 7	

6 Test Programs and Diagnostics

OPTI 1 System

The AVL OPTI 1 is equipped with diagnostic routines designed to assist the user in testing the operation of the each system component. These tests can be selected in the **Diagnostics Menu.** An overview of the diagnostic tests available is located in Section 2. This section describes each diagnostic test and the expected result.

Diagnostic 1

Barometer

The BARO test displays the system barometric pressure in a real-time mode. This test can be used to verify the internal pressure transducer is measuring correctly. The barometric pressure should be compared to the laboratory reference standard and calibrated accordingly. The operator can adjust the barometric pressure by entering the correct value in the SETUP - BARO menu. To calibrate the internal barometer follow the adjustment procedure outlined in Chapter 7.

Battery

The OPTI 1 may be powered by an internal battery pack or by an external battery charger, which is supplied with the analyzer. This test allows the user to determine the voltage of either the battery or external battery charger. When the charger is plugged in and connected to the analyzer, the display indicates the battery charger voltage. When the analyzer is powered from the internal battery, the displayed voltage is the battery voltage. When the internal battery powers the OPTI 1, the voltage must be greater than 11.2 volts for correct operation. While the external battery charger is connected, the internal battery is being charged. The main board contains the required circuitry to monitor and control the battery charging system. An LED is visible through the rear cover indicating battery charge status. A solid ON light indicates the battery is charging, while a fast flashing light (4 times per second) indicates the battery is fully charged. The battery LED will be OFF when the analyzer is not connected to the external charger. A slowly blinking light (once per second) indicates a very cold, very hot or defective battery.

Temperature

The temperature diagnostic test displays three system-operating temperatures. T1 displays the SMC top plate temperature, T2 displays the SMC lower plate temperature and T3 displays the ambient temperature of the internal chassis and is used for the fan control. Circuitry on the main board, optics module, and SMC heater board provides temperature control for the analyzer. The following specifications are required for proper operation:

T1 = 37.00° C ±0.05° C
T2 = 37.15° C ±0.05° C
T3 = Internal analyzer temperature

Adjustment of the temperature circuitry is described in Chapter 7, Adjustments.

Gas Pressure

The newly installed calibration gas cylinder contains a gas pressure of 140-psi (9.7 bar) and is regulated and monitored by the gas module assembly. The gas pressure sensor portion of the module provides gas pressure status to the OPTI 1 analyzer. If the gas bottle pressure falls below approx. 35 psi, the switch closes (low pressure). The pressure needs to be above approx. 50 psi for the switch to open (high pressure). This diagnostic test indicates HIGH PRESSURE or LOW PRESSURE depending on the remaining gas cylinder pressure. When this diagnostic test is completed, an additional screen is displayed to allow replacement of the gas bottle and a gas purge sequence to be initiated by the user.

Cleaning

The OPTI 1 provides an automated cleaning routine that can be performed by selecting the diagnostic cleaning menu. Operator instructions are displayed to provide the user with a step-by-step guide for completion of the cleaning routine. First, the operator will be instructed to remove the peristaltic pump cartridge followed by pressing J . Next the operator will be instructed to place a syringe in the front peristaltic pump receptacle. The syringe should contain a mild cleaning solution such as a 30% bleach solution. Press J upon completion. The OPTI 1 will now instruct the operator to perform a wash. To do this, move the cleaning solution back and forth to flush the fluidic tubing. A tissue should also be placed at the inlet port of the SMC to catch any cleaning solution, which may be pushed, through the port. Press J upon completion. The operator will now be instructed to reinsert the pump cartridge. Press J to confirm this action and complete the cleaning procedure.

Flow

Performing a flow test requires the use of a new cassette. The purpose of the flow test is to check proper operation of the pump, gas module and to detect leaks downstream from the pump.
At the end of the flow test, a pass/fail as well as two flow numbers are displayed. If the flow numbers are 99.99, this part of the test failed and no number could be obtained.
Press J to start the test. First, the gas pressure is turned on (tubing upstream from pump is pressurized). With the pump stopped, the fluid light gates L1 and L2 check for the buffer to remain in the cassette. If the buffer is pushed out, the test fails and the pump cartridge needs to be replaced.
Now the pump starts pumping slowly, while L2 is looking for the trailing edge of the buffer. If the trailing edge is not detected within a certain time-out, the test fails. Check for leaks downstream from the pump. Replace the SMC gas seal and the pump cartridge receptacles.
Once L2 has detected the trailing edge, L1 is looking for the trailing edge of the buffer. L1 must detect the trailing edge between 1.2 seconds and 5.2 seconds. The actual time is indicated by the first number on the display at the end of the test. If the number is less than 1.2 seconds, replace the gas bottle and check the output pressure of the gas module (2.5 psi ± 0.5 psi).
Next, the system reverses the pump direction and measures the time of the buffer movement between LG1 and LG2. Since now the pump transports the buffer against the gas pressure, the time needs to be between 4.0 seconds and 8.0 seconds to pass the test. The second number displayed at the end of the flow test is the actual time. If the time is below 4.0 seconds, replace the gas bottle and check the output pressure of the gas module. If the time exceeds 8.0 seconds, replace the pump cartridge.

Optics Test

During the optics test, the optics module is warmed for 30 seconds to stabilize the optics system. Readings are then taken for each of the three channels for one minute. The test results are then calculated and printed to include the mean value of each channel's intensity, noise and CV %.
To test the proper function of the optics module and electronics, start the Optics test and insert an SRC (Low, Medium or High level).
The values printed at the end of the test should be within the following limits:

pH:	AVG 40'000 to 160'000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%
PCO_2:	AVG 40'000 to 160'000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%
PO_2:	AVG 25'000 to 160'000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%

If a value is out of range, repeat the test with another SRC.

Diagnostic 2

Printer Test

The internal thermal printer can be tested using the printer test diagnostic. Selection of the printer test prints the following message:

```
  ! ” # $ % ’ ( ) * + , - . / 0 1 2 3 4 5 6 7 8
9 : ; < = > ? & ABCDEFGHIJKLMNOPQ
RSTUVWXYZ                    abcdefghij
klmnopqrstuvwxyz
```

Keypad Test

The keypad test when selected responds with the pressed key’s information displayed in the analyzer’s LCD display. Each key can be pressed successively until all keys have been tested. To exit this diagnostic routine, press E twice to return to the diagnostic menu.

Display Test

The display test can be selected to test the LCD display module. As this test is selected, each of the 24 characters in both rows of the display will be illuminated to indicate the function of the entire display module. The test will repeat every several seconds until E is pressed to end the test.

Barcode Test

The barcode test is designed to test the function of either the internal barcode or the optional external barcode. To perform the barcode test press J to start the test. Swipe a valid barcode label and the analyzer will display the barcode information on the LCD display.

RS232 Test

The RS232 Serial Interface test is included to test the serial interface function. To perform the test, first select the RS232 test. Displayed instructions will request the user to jumper pin 2 & 3 of the 9-pin serial interface connector on the rear panel of the analyzer. When the jumper is in place press J to start the test. Test results will be displayed indicating either PASS or FAIL.

Cover Test

The cover test is used to test the function of the SMC cover. When the cover is closed the display will indicate **Closed**. Open the SMC Cover and the display should indicate **Open**. To exit this test, press the E key and return to the diagnostic menu.

Fset

The Fset menu permits viewing and modification of factory-set values stored in the EEPROM. At the prompt **Password <ENTER>** type **3350 <ENTER>**.

IDAC1 and **IDAC2** are default DAC values for LG1 and LG2. The default DAC values are used only if no valid DAC values are available from the last measurement.

The serial number displayed should match the last four digits of the serial number printed on the serial number label.

pH, **CO_2** and **O_2 false light** values are subtracted from the signal intensities and compensate for amplifier offset and photodiode dark currents.

CDetect Low Limit is used as the reference value for the cassette detect sensor with SMC cover open and no cassette inserted.

CDetect Up Limit is used as the reference value for the cassette detect sensor with SMC cover closed and cassette inserted.

CDetect Low Offset is added to the **CDetect Low Limit** and is the threshold for a 'cassette present' condition. The **CDetect Low Offset** is always 100.

CDectect Up Factor is multiplied with the **CDetect Up Limit** and is the threshold for a 'cassette not present' condition. The **CDectect Up Factor** is always 0.6.

The **Home Offset** value indicates the number of motor steps between the home light gate position and the cassette valve home position.

Gas Module Type: GR RE allows selection between 'green dot' and 'red dot' gas modules. Depending on its revision level, the gas module MB7001 has either a green or red dot applied. Generally, instruments with S/N < 1530 are marked with a red dot.

PHR Correction: 160. These are factory-set optics calibration values which should not be changed.

PCR Correction: 75. These are factory-set optics calibration values which should not be changed.

Diagnostic 3

Valve Test

The gas module incorporates two gas valves: an On/Off valve on the high-pressure side which enables/disables the gas flow, and a 3-way valve, which connects the pump to the vent or to the gas module. Both valves are wired in parallel, i.e. they are activated/deactivated simultaneously.
The valve test allows the user to test the gas valves. When the test is started, the analyzer displays the valve status. Pressing the right or left arrow key will turn OFF and ON the valve. Press E to exit the valve test.
This test can be used for checking adequate gas flow and the output pressure of the gas module (2.5 psi ± 0.5 psi). Remove the pump cartridge and turn the valve on. The gas will free-flow out the rear pump cartridge receptacle. Connect a piece of tubing and submerge it in water to check for adequate flow. Vigorous bubbles indicate adequate flow. If flow is inadequate, replace the gas module. To check the output pressure, connect a calibrated, digital pressure meter to the rear pump receptacle. If the pressure is outside the specified limits, replace the gas module. Note that output pressure is factory-set and cannot be adjusted.

Vdrive Test

The valve drive test is used to test and determine the position and movement of the valve drive. Select the Vdrive menu to begin the test. Position 0 will be displayed. Press the right arrow key to select valve position 1 - 12 and press J . The valve drive will move to the desired position. To test the home position, select position 0 and press J . When the valve drive has reached home position, insert a new cassette. The cassette should fit over the valve drive pins without any resistance. The home position can be adjusted using the Fset menu. Increasing the number will adjust the home position counter-clockwise, decreasing the number will adjust it clockwise.

Peristaltic Pump Test

The pump test is used to test the function of the peristaltic pump. When the pump test is selected, the OPTI 1 will perform an automatic test of the peristaltic pump including clockwise and counter-clockwise rotation and a cycling of each pump speed used in normal operation. Once the test routine is started, correct pump operation can be observed by opening the printer access cover.
Note that the pump speed is computer-controlled and adjustment is therefore not necessary.

LED Test

The LED test displays the operating voltage of the internal LED's and allows for verification of operation and performance. The LED test will display the following LED's:

LT1	Cassette seat detect front (SMC Top Cover)
LT2	Cassette seat detect rear (SMC Top Cover)
L1	Front fluid detect LED
L2	Rear fluid detect LED
CD	Cassette detect LED

Memory Test

The **Memory Test** can be selected and the analyzer performs a check of the system memory. The analyzer displays **MEMORY OK** when the system successfully verifies the memory.

Software Version

Selecting the **Software Version** menu displays the currently installed software revision level. Pressing the right arrow key displays the software version for the optics module.

Reports

With the **Reports** menu, the user can select one of four reports to be printed. The **Error Report** saves the last 50 system errors and can be printed. When the number of system errors exceeds 50 the oldest error is deleted and replaced by the most recent error. A **Calibration Report** can also be printed which provides a calibration data summary of the stored patient and QC measurements. The third report is an **SRC Report**, which provides a summary of all stored SRC results. The **Configuration Report** prints out all user selectable settings. A printout of this report is particularly helpful prior to erasing memory (e.g. software update).

Error Report:

```
AVL OPTI 1
ERROR REPORT
30-AUG-96   14:00
S/N: 1000

6-JUL- 96    08:45
ERROR - Cassette Misseat 2
```

Date/Time of error occurrence
Type of error

SRC Report:

```
AVL OPTI 1
SRC Diagnostic Report
30-AUG-96   14:02
S/N: 1000
30Aug96 09:09 SRCID:742104
mV:     90.4     95.9     74.0
%DR:   0.06     0.09     0.06
%SEE:  0.01     0.02     0.01
```

Date/Time of start of SRC run
Intensity/1000 must be > 7mV
Drift must be < 0.3% for all parameters
Noise must be < 0.2% for all parameters

Calibration Report:

```
AVL OPTI 1
Calibration Report
30-APR-98   14:00
S/N: 1000

30-AUG-96 11:18 LOT: 63407
          mV    Drift   T     W
Ph       223.0   -2.4   33   102
PCO2     301.3   -0.4   33   103
PO2      625.9   -2.8   33   112
```

Date/Time of start of measurement
Intensity/1000 must be > 7mV
Drift during gas calibration, no limits apply
T: time needed for calibration in sec.
T must be less than 75 seconds
W: ratio between warm QC and gas cal.
pH and CO2 must be with 5 units of each other
O2 needs to be >93 and < 130
If T is out of limits: Bad Calibration Error
If W is out of limits: Bad Cassette Error

Configuration Report:

```
        AVL OPTI 1
    Configuration Report
      30-AUG-97   14:02
S/N: 1000

Version: AOPX1.50dp

Baro. Factor : 0.648
Patient Info -
   Pat. ID       : ON / Opt.
   Oper. ID      : ON / Opt.
   Temp.         : ON
   THb           : ON
    Sex          : ON
    Age          : ON
   FIO2          : ON
   Hb Type       : ON
   P50           : ON
   RQ            : ON
   Def. THb      : 15.0 g/dL
   Def. FIO2     : 0.21
   Def. RQ       : 0.84
   Def. P50      : 26.7 mmHg
   Reference Limits -

   Controls Info -

   Printouts -

   Calculated Parameters -

   Security -

   Miscellaneous -

   Correlation Factors -

   Communications -

   Language :  English

   Battery Saver -
```

This report prints the current programmed instrument configuration. This should be printed before changing instrument software.

Current Software Version

Barometric Pressure Sensor factor

Patient Information parameters programming

OPTI CCA System

The AVL OPTI CCA is equipped with diagnostic routines designed to assist the user in testing the operation of the each system component. These tests can be selected in the **Diagnostics Menu.** An overview of the diagnostic tests available is located in Section 2. This section describes each diagnostic test and the expected result.

Diagnostic 1

Barometer

The BARO test displays the system barometric pressure in a real-time mode. This test can be used to verify the internal pressure transducer is measuring correctly. The barometric pressure should be compared to the laboratory reference standard and calibrated accordingly. The operator can adjust the barometric pressure by entering the correct value in the SETUP – BARO menu. To calibrate the internal barometer follow the adjustment procedure outlined in Chapter 7.

Battery

The OPTI CCA may be powered by an internal battery pack or by an external battery charger that is supplied with the analyzer. This test allows the user to determine the voltage of either the battery or external battery charger. When the charger is plugged in and connected to the analyzer, the display indicates the battery charger voltage. When the analyzer is powered from the internal battery, the displayed voltage is the battery voltage. When the internal battery powers the OPTI CCA, the voltage must be greater than 11.2 volts for correct operation. While the external battery charger is connected, the internal battery is being charged. The main board contains the required circuitry to monitor and control the battery charging system. An LED is visible through the rear cover indicating battery charge status. A solid ON light indicates the battery is charging, while a fast flashing light (4 times per second) indicates the battery is fully charged. The battery LED will be OFF when the analyzer is not connected to the external charger. A slowly blinking light (once per second) indicates a very cold, very hot or defective battery.

Temperature

The temperature diagnostic test displays three system-operating temperatures. T1 displays the SMC top plate temperature, T2 displays the SMC lower plate temperature and T3 displays the ambient temperature of the internal chassis and is used for the fan control. Circuitry on the main board, optics module, and SMC heater board provides temperature control for the analyzer. The following specifications are required for proper operation:

T1 = 37.00° C ±0.05° C
T2 = 37.15° C ±0.05° C
T3 = Internal analyzer temperature

Adjustment of the temperature circuitry is described in Chapter 7, Adjustments.

Gas Pressure

The newly installed calibration gas cylinder contains a gas pressure of 140 psi (9.7 bar) and is regulated and monitored by the gas module assembly. The gas pressure sensor portion of the module provides gas pressure status to the OPTI CCA analyzer. If the gas bottle pressure falls below approx. 35 psi, the switch closes (low pressure). The pressure needs to be above approx. 50 psi for the switch to open (high pressure). This diagnostic test indicates HIGH PRESSURE or LOW PRESSURE depending on the remaining gas cylinder pressure. When this diagnostic test is completed, an additional screen is displayed to allow replacement of the gas bottle and a gas purge sequence to be initiated by the user.

Version

Selecting the **Version** menu displays the currently installed software revision level. Pressing the right arrow key displays the software version for the optics module.

Reports

With the **Reports** menu, the user can select one of four reports to be printed. The **Error Report** saves the last 50 system errors and can be printed. When the number of system errors exceeds 50 the oldest error is deleted and replaced by the most recent error. A **Calibration Report** can also be printed which provides a calibration data summary of the stored patient and QC measurements. The third report is an **SRC Report**, which provides a summary of all stored SRC results. The **Configuration Report** prints out all user selectable settings. A printout of this report is particularly helpful prior to erasing memory (e.g. software update).

Error Report:

```
        AVL OPTI CCA
       ERROR REPORT
       30-APR-98   14:00
S/N: 1000

6-JUL- 96    08:45
ERROR - Cassette Misseat 2
```

Date/Time of error occurrence
Type of error

SRC Report:

```
        AVL OPTI CCA
      SRC Diagnostic Report
       30-APR-98   14:00
S/N: 1000
30Aug96 09:09 SRCID:742104
mV:     90.4     95.9     74.0
%DR:   0.06     0.09     0.06
%SEE:  0.01     0.02     0.01
```

Date/Time of start of SRC run
Intensity/1000 must be > 7mV
Drift must be < 0.3% for all parameters
Noise must be < 0.2% for all parameters

Calibration Report:

```
        AVL OPTI CCA
       Calibration Report
       30-APR-98   14:00
S/N: 1000

30-AUG-96 11:18 LOT: 63407
          mV    Drift   T     W
Ph       223.0   -2.4   33    102
PCO2     301.3   -0.4   33    103
PO2      625.9   -2.8   33    112
Na+      180.1    0.0   33    105
K+       452.4    7.2   33     93
```

Date/Time of start of measurement
Intensity/1000 must be > 7mV
Drift during gas calibration, no limits apply
T: time needed for calibration in sec.
T must be less than 75 seconds

W: ratio between warm QC and gas cal.
pH and CO2 must be with 5 units of each other
O2 needs to be >93 and < 130
If T is out of limits: Bad Calibration Error
If W is out of limits: Bad Cassette Error

Configuration Report:

```
        AVL OPTI CCA
      Configuration Report
       30-APR-98   14:00
S/N: 1000

Version: AOPX1.50dp

Baro. Factor : 0.648
Patient Info -
   Pat. ID        : ON / Opt.
   Oper. ID       : ON / Opt.
  Temp.           : ON
  THb             : ON
   Sex            : ON
   Age            : ON
  FIO2            : ON
  Hb Type         : ON
  P50             : ON
  RQ              : ON
  Def. THb    : 15.0 g/dL
  Def. FIO2   : 0.21
  Def. RQ     : 0.84
  Def. P50    : 26.7 mmHg
  Reference Limits -

  Controls Info -

  Printouts -

  Calculated Parameters -

  Security -

  Miscellaneous -

  Correlation Factors -

  Communications -

  Language :  English

  Battery Saver -
```

This report prints the current programmed instrument configuration. This should be printed before changing instrument software.

Current Software Version

Barometric Pressure Sensor factor

Patient Information parameters programming

Barcode

The barcode test is designed to test the function of either the internal barcode or the optional external barcode. To perform the barcode test press J to start the test. Swipe a valid barcode label and the analyzer will display the barcode information on the LCD display.

Diagnostic 2

Printer Test

The internal thermal printer can be tested using the printer test diagnostic. Selection of the printer test prints the following message:

```
  ! ” # $ % ’ ( ) * + , - . / 0 1 2 3 4 5 6 7 8
9 : ; < = > ? & ABCDEFGHIJKLMNOPQ
RSTUVWXYZ                    abcdefghij
klmnopqrstuvwxyz
```

Optics Test

During the optics test, the optics module is warmed for 30 seconds to stabilize the optics system. Readings are then taken for each of the three channels for one minute. The test results are then calculated and printed to include the mean value of each channel’s intensity, noise and CV %.
To test the proper function of the optics module and electronics, start the Optics test and insert an SRC (Low, Medium or High level).
The values printed at the end of the test should be within the following limits:

pH:	AVG 110,000 to 300,000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%
PCO_2:	AVG 120,000 to 250,000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%
PO_2:	AVG 130,000 to 300,000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%
Na	AVG 100,000 to 270,000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%
K	AVG 100,000 to 250,000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%
Ca	AVG 300,000 to 560,000	%DR: -1.0% to +1.0%	%SEE: 0.0% to 0.1%

If a value is out of range, repeat the test with another SRC.

LED Test

The LED test displays the operating voltage of the internal LED's and allows for verification of operation and performance. The LED 1 test will display the following LED's:

LT1	Cassette seat detect front (SMC Top Cover)
L1	Front fluid detect LED
L2	Rear fluid detect LED
L3	Rear fluid detect LED

Press ENTER to view the second portion of the LED test. The LED 2 test will display the following LED's:

Cover:	Open or Closed SMC Cover
CD	Cassette detect LED

Interface Test

The RS232 Serial Interface test is included to test the serial interface function. To perform the test first select the RS232 test. Displayed instructions will request the user to jumper pin 2 & 3 of the 9-pin serial interface connector on the rear panel of the analyzer. When the jumper is in place press J to start the test. Test results will be displayed indicating either PASS or FAIL.

IR Test

The IR Loopback test is included to test the IR interface function. To perform the test first select the IR test. Test results will be displayed indicating either PASS or FAIL.

Fan Test

The FAN test allows the cooling fan to be turned ON and OFF using the analyzer keypad. Turn the FAN ON and check for proper airflow at the fan vents on the rear of the analyzer.

Fset

The Fset menu permits viewing and modification of factory-set values stored in the EEPROM. At the prompt **Password <ENTER>** type **3350 <ENTER>**.

Select **Instrument**

IDAC1, IDAC2 and, **IDAC3** are default DAC values for LG1, LG2 and LG3. The default DAC values are used only if no valid DAC values are available from the last measurement.

The serial number displayed should match the last four digits of the serial number printed on the serial number label.

pH, **O_2** and **CO_2, Ca, K, Na false light** values are subtracted from the signal intensities and compensate for amplifier offset and photodiode dark currents.

CDetect Low Limit is used as the reference value for the cassette detect sensor with SMC cover open and no cassette inserted.

CDetect Up Limit is used as the reference value for the cassette detect sensor with SMC cover closed and cassette inserted.

CDetect Low Offset is added to the **CDetect Low Limit** and is the threshold for a 'cassette present' condition. The **CDetect Low Offset** is always 500.

CDectect Up Factor is multiplied with the **CDetect Up Limit** and is the threshold for a 'cassette not present' condition. The **CDectect Up Factor** is always 0.8.

Gas Module Type: GR This selection must always be set to GR.

Home Offset value indicates the number of motor steps between the home light gate position and the cassette valve home position.

PHR Correction: 160. These are factory-set optics calibration values that should not be changed.

PCR Correction: 75. These are factory-set optics calibration values that should not be changed.

Fset Cont'd.

Laser Parameters:

WQC_SETTLE:

WQC_NUM:

SAM_SETTLE:

SAM_NUM:

K1:	**F1: 0.000**
K2:	**F2: 0.000**
K3:	**F3: 0.000**
K4:	**F4: 1.000**
K5:	**F5: 1.000**
K6:	**F6:**
K7:	**F7:**
K8:	**F8:**
K9:	**F9:**
K10:	**F10:**
K11:	**F11:**
K12:	**F12:**

Note: Except F1 – F5, these are factory-set optics calibration values, which should not be changed. F1 through F5 are values, which are update during the tHb Calibration. The values, which are listed for F1 through F5, are default values and can be entered through FSET

Diagnostic 3

Valve Test

The gas module incorporates two gas valves: an On/Off valve on the high-pressure side which enables/disables the gas flow, and a 3-way valve that connects the pump to the vent or to the gas module. Both valves are wired in parallel and they are activated/ deactivated simultaneously.

The valve test allows the user to test the gas valves. When the test is started, the analyzer displays the valve status. Pressing the right or left arrow key will turn OFF and ON the valve. Press E to exit the valve test.

This test can be used for checking adequate gas flow and the output pressure of the gas module (2.5 psi ± 0.5 psi). Remove the pump cartridge and turn the valve on. The gas will free-flow out the rear pump cartridge receptacle. Connect a piece of tubing and submerge it in water to check for adequate flow. Vigorous bubbles indicate adequate flow. If flow is inadequate, replace the gas module. To check the output pressure, connect a calibrated, digital pressure meter to the rear pump receptacle. If the pressure is outside the specified limits, replace the gas module. Note that output pressure is factory-set and cannot be adjusted.

Flow Test

Performing a flow test requires the use of a new cassette. The purpose of the flow test is to check proper operation of the pump, gas module and to detect leaks downstream from the pump.

At the end of the flow test, a pass/fail as well as two flow numbers are displayed. If the flow numbers are 99.99, this part of the test failed and no number could be obtained.

Press J to start the test. First, the gas pressure is turned on (tubing upstream from pump is pressurized). With the pump stopped, the fluid light gates L1 and L2 check for the buffer to remain in the cassette. If the buffer is pushed out, the test fails and the pump cartridge needs to be replaced.

Now the pump starts pumping slowly, while L2 is looking for the trailing edge of the buffer. If the trailing edge is not detected within a certain time-out, the test fails. Check for leaks downstream from the pump. Replace the SMC gas seal and the pump cartridge receptacles.

Once L2 has detected the trailing edge, L1 is looking for the trailing edge of the buffer. L1 must detect the trailing edge between 1.2 seconds and 5.2 seconds. The actual time is indicated by the first number on the display at the end of the test. If the number is less than 1.2 seconds, replace the gas bottle and check the output pressure of the gas module (2.5 psi ± 0.5 psi).

Next, the system reverses the pump direction and measures the time of the buffer movement between LG1 and LG2. Since now the pump transports the buffer against the gas pressure, the time needs to be between 4.0 seconds and 8.0 seconds to pass the test. The second number displayed at the end of the flow test is the actual time. If the time is below 4.0 seconds, replace the gas bottle and check the output pressure of the gas module. If the time exceeds 8.0 seconds, replace the pump cartridge.

Display Test

The display test can be selected to test the LCD display module. As this test is selected, each of the 24 characters in both rows of the display will be illuminated to indicate the function of the entire display module. The test will repeat every several seconds until E is pressed to end the test.

VDrive Test

The valve drive test is used to test and determine the position and movement of the valve drive. Select the VDrive menu to begin the test. Position 0 will be displayed. Press the right arrow key to select valve position 1 - 12 and press J . The valve drive will move to the desired position. To test the home position, select position 0 and press J . When the valve drive has reached home position, insert a new cassette. The cassette should fit over the valve drive pins without any resistance. The home position can be adjusted using the Fset menu. Increasing the number will adjust the home position counter-clockwise, decreasing the number will adjust it clockwise.

Peristaltic Pump Test

The pump test is used to test the function of the peristaltic pump. When the pump test is selected, the OPTI CCA will perform an automatic test of the peristaltic pump including clockwise and counter-clockwise rotation and a cycling of each pump speed used in normal operation. Once the test routine is started, correct pump operation can be observed by opening the printer access cover.
Note that the pump speed is computer-controlled and adjustment is therefore not necessary.

Keypad Test

The keypad test when selected responds with the pressed key's information displayed in the analyzer's LCD display. Each key can be pressed successively until all keys have been tested. To exit this diagnostic routine, press E twice to return to the diagnostic menu.

7 Adjustments

OPTI 1 System

The AVL OPTI 1 is designed to require only minimal adjustments by field service personnel. The main board contains 6 electrical adjustments; however, field service personnel may make only three adjustments. Three potentiometers (R40, R100, and R136) are sealed and are factory adjustments only. These factory-only adjustments require special test fixtures and can only be performed at the factory. Field personnel may make the following adjustments:

Barometric Pressure (R35)

Sample Measurement Chamber Temperature (R97 and R95)

For all adjustments first turn the analyzer power off. Open the analyzer lower housing by removing seven screws on the bottom of the analyzer. Set the analyzer upper housing on its side to access the keypad. Turn the analyzer power on. After completion of the adjustments, turn off the analyzer power before reassembly of the analyzer. Once reassembly is completed, turn the analyzer power on to resume normal operation.

Barometric Pressure

The operator through keyboard entry in the Setup mode may adjust barometric pressure. The displayed pressure may be adjusted ±50 mmHg through keyboard entry. Use the following procedure if barometric pressure requires adjustment beyond the span of the keyboard entry.

Using the analyzer keypad, select the Diagnostics Menu and then the barometer test to enable the barometric pressure. Locate R35 and adjust for the correct barometric pressure on the analyzer display.

Sample Measurement Chamber Temperature

Note: Prior to performing temperature adjustment turn on the analyzer power and allow a 10-minute warm-up to ensure temperature stability.

Using the analyzer keypad, select the Diagnostics Menu and then the temperature test to enable the display of analyzer temperature. For temperature T1, locate R97 and adjust for a display of 37.00 ± 0.03 °C. After adjustment of R97 allow 5 minutes for temperature to stabilize. Locate R95 and adjust for a display of 37.15 ±0.03 °C for temperature T2.

Note: Always adjust temperature T1 before adjusting T2 as temperature T2 depends on temperature T1. R95 adjusts the difference between T1 and T2 which must be 0.15 °C.

OPTI CCA System

The AVL OPTI CCA is designed to require only minimal adjustments by field service personnel. The main board contains nine electrical adjustments; however, field service personnel may make only three adjustments. Six potentiometers are factory adjustments only:

R74	Barometer Slope
R129	Top Cover Temperature
R161	Optics Temperature
R215	Laser Intensity
R217	Laser Intensity
R277	LED Intensity (tHb/SO_2)

These factory-only adjustments require special test fixtures and can only be performed at the factory.

Field personnel may make the following adjustments:

Barometric Pressure (R67)

Sample Measurement Chamber Temperature (R126 and R124)

For all adjustments first turn the analyzer power off. Open the analyzer lower housing by removing seven screws on the bottom of the analyzer. Set the analyzer upper housing on its side to access the keypad. Turn the analyzer power on. After completion of the adjustments, turn off the analyzer power before reassembly of the analyzer. Once reassembly is completed, turn the analyzer power on to resume normal operation.

Barometric Pressure

The operator through keyboard entry in the Setup mode may adjust barometric pressure. The displayed pressure may be adjusted ±50 mmHg through keyboard entry. Use the following procedure if barometric pressure requires adjustment beyond the span of the keyboard entry.

Using the analyzer keypad, select the Diagnostics Menu and then the barometer test to enable the barometric pressure. Locate R67 and adjust for the correct barometric pressure on the analyzer display.

Sample Measurement Chamber Temperature

Note: Prior to performing temperature adjustment turn on the analyzer power and allow a 10-minute warm-up to ensure temperature stability.

Using the analyzer keypad, select the Diagnostics Menu and then the temperature test to enable the display of analyzer temperature. Locate R126 and adjust for a display of 37.00 ± 0.03 °C for temperature T1. After adjustment of R126 allow 5 minutes for temperature to stabilize. Locate R124 and adjust for a display of 37.15 ± 0.03 °C for temperature T2.

Note: Always adjust temperature T1 before adjusting T2 as temperature T2 depends on temperature T1. R124 adjusts the difference between T1 and T2 which must be 0.15 °C.

8 Troubleshooting

OPTI System

The AVL OPTI and OPTI CCA analyzers are equipped with sensors and diagnostic software that control, monitor and detect analyzer system status. Operator messages indicating system status are displayed to provide the operator with useful information to determine the cause of detected system errors or malfunctions. System errors are also stored in memory and an error report can be printed that lists the last 50 status messages.

Displayed Alarms

There are four types of displayed system status messages:

SYSTEM STOP ALARMS

These alarms indicate system conditions that must be resolved before system operation can be continued.

SYSTEM ERROR ALARMS

These errors occur during sample analysis and are specific to the current sample being analyzed. Error alarms indicate the status of the current measurement or additional required operator entry.

SYSTEM WARNING MESSAGES

System warning messages notify the operator of conditions requiring operator intervention to complete the current measurement.

SYSTEM INFORMATION MESSAGES

These messages describe operator instructions or confirm completion of operator selections.

The following section describes each displayed message and the causes and conditions that generate this message. Further in the chapter probable causes and fault isolation are provided for each status message.

SYSTEM STOP MESSAGES

STOP - Temp Out of Range Please Wait Menu<ENTER>	When the sample measurement chamber bottom plate temperature is outside the range of 37.10° C to 37.20° C or the top plate is outside the range of 36.95° C to 37.05° C this error is displayed. Normal operation can only be resumed when the temperature is in range. To check the system temperature, access the **DIAG1 Temperature** menu to display system temperature. Temperature T1 indicates top plate temperature while T2 indicates bottom plate temperature. If this error condition remains, perform temperature adjustment procedure as described in Section 7, Adjustments.
STOP - Low Battery Recharge Now	During prolonged periods of use, the battery charge may become depleted and normal operation can no longer be continued. This message will be displayed when the battery voltage is less than 11.2 volts. System operation is halted until the error condition is resolved in order to prevent the possible memory corruption. Replace the battery pack with a fully charged spare or connect the battery charger to recharge the battery pack.
STOP - Low Battery Recharge and Cycle Power	If the battery voltage drops below 10.5 V, the unit will lock up to prevent memory corruption. To resume operation, connect the instrument to the power supply and cycle the power.
STOP - Low Gas Replace Now <ESC>	An internal gas cylinder is used to provide a calibration gas source that is used when calibrating each sample cassette. When the gas pressure sensed by the internal gas manifold assembly detects pressure below 35 psi, too low to perform a successful calibration, this error is displayed. Replace the gas cylinder with a full cylinder to continue normal operation. Access **DIAG1 Gas** to display the current gas pressure status.

```
STOP - Need New SRC Data
Must Run SRCs     <ESC>
```

Standard Reference Cassettes (SRC's) are measured to verify the analyzer's measuring performance. In analyzer programming, the key operator may select QC Lockout for 1, 2 or 3 levels. Depending on the selection, 1, 2 or 3 levels of SRC's are required to be run daily. If no SRC records for the last 24 hour period exist in the database, this message is displayed. Performing SRC measurements of the levels required will remove this error message.

```
STOP -  System Error
Cycle Power for Reset
```

The STOP System Error is displayed when the operating software detects incorrect communication between the main microprocessor and the optics module microprocessor and halts routine operation. This indication may occur if the system software becomes corrupted. Generally, cycling power OFF and then ON can restart the system. The OPTI will restart and complete the start-up initializing routine for normal operation.

```
STOP - New Cassette Lot
Must Run Controls  <ESC>
```

When "New Lot" or "Controls" is selected under QC-Lockout, the OPTI will detect a difference in the cassette lot number from the previous cassette. When the difference is detected, the **Stop - New Cassette Lot** message is displayed. To continue the operator must verify the new lot of cassettes by measuring QC material.

```
STOP - Memory Error
Database Deleted   <ESC>
```

Vital analyzer parameters are stored in the system's EEPROM. Upon each power on, this EEPROM data is checked against its copy in RAM. If the values do not match due to memory corruption, this error is displayed. The analyzer will perform a complete reinitialization which includes deletion of the stored data. In addition, for diagnostic purposes, a report outlining the old values in RAM and the new initialized values can be printed if `J` is pressed.

SYSTEM ERROR MESSAGES

ERROR - Unstable Sensors Discard Cassette <ESC>

This error occurs during a sample measurement. In this condition the cassette successfully calibrated and detected correct aspiration of the sample. During a sample measurement, the OPTI monitors each of the sensor's output for an endpoint. When two or more parameters continue to drift and do not reach endpoint this message is displayed.

ERROR-Cassette MisSeat 1 Reinsert or <ESC>

When the OPTI detects that the SMC Cover has been closed, the SMC top light gates LT1 and LT2 are checked to ensure proper seating of the cassette. If a cassette has been misseated, the spring loaded top plate is not in its correct position and causes either of the SMC top light gates to sense this misseat condition. Open the SMC cover and reposition the cassette. If error persists, insert a new

ERROR-Cassette MisSeat 2 Reinsert or <ESC>

Once a cassette has been inserted into the SMC and the cover is closed, the front and rear light gates LG1 and LG2 detect buffer is present in the cassette. Normally the buffer is removed during the calibration process. When this message is displayed, the OPTI assumes the cassette is seated improperly or the cassette is not sealed firmly to the SMC port. Open the SMC cover and reposition the cassette.

ERROR-Cassette MisSeat 2 Discard Cassette <ESC>

If reinserting the cassette does not eliminate the Cassette Misseat Error, this message will be displayed.

ERROR - Bad Cassette Discard Cassette <ESC>

During cassette calibration, each sensor is checked for an endpoint. If all sensors reach endpoint, calculations are performed for each sensor comparing calibration information to initial optics data. This message is displayed if two or more of the sensor calculations are outside the limits.

ERROR - Bad Calibration Discard Cassette <ESC>	If two or more sensors did not reach a stable endpoint, the calibration is considered “failed” and this message is displayed.
ERROR - Cal Expired Discard Cassette <ESC>	Following insertion of a cassette, a one-point cassette calibration will occur. The cassette will remain calibrated for a 10-minute period. If no measurement occurs within 10 minutes, the cassette will be recalibrated. This process will continue for up to 30 minutes. If no sample has been aspirated during this thirty-minute interval, the cassette must be discarded. For OPTI CCA calibration expires in 10 minutes.
ERROR - Dirty Optics Clean Cass./Optics <ESC>	After the cassette has been repositioned following an initial Misseat 2 Error, the sample light gates LG1 and LG2/(LG3) monitor the transition in the cassette from buffer to air. When the cassette buffer is removed, the light gates can not detect this buffer-to-air transition. The OPTI assumes that the optics are dirty when no buffer transition is detected.
ERROR - Bad Sensors Discard Cassette <ESC>	After insertion of a new cassette, an optics test is performed. Each sensor must provide a reading of greater than 10,000 counts for an adequate sensor output. If any sensor fails to meet these criteria, no sample measurement can be performed. A manual optics test can be performed in System Diagnostics to confirm the cassette performance.
ERROR - Invalid Barcode Continue <ENTER>	During sample analysis the barcode is read. If the analyzer is unable to determine the barcode information or the system software does not support the barcode format this message will be displayed. The barcode information is checked to determine if the barcode is a cassette, compares the checksum, and compares calibration parameters to expected ranges. A barcode test can be performed by accessing **DIAG Barcode** and swiping a valid barcode. The barcode data will be displayed. The OPTI currently supports the following barcode formats: Codabar, Code39, Interleaved 2 of 5, UPC, EAN.
ERROR - Invalid Barcode Check TimeDate <ENTER>	If the expiration date does not match the current date/time setting, this message is displayed.

ERROR - No Pat. ID Entry Edit Data<ENTER>or<ESC>	During analyzer setup and programming a selection can be made to require entry of patient ID for each sample analyzed. The analyzer will not report sample results until a patient ID is entered. Enter a patient ID to obtain a printed sample report.
ERROR - No Op. ID Entry Edit Data<ENTER>or<ESC>	During analyzer setup and programming a selection can be made to require entry of operator ID for each sample analyzed. The analyzer will not report sample results until an operator ID is entered. Enter an operator ID to obtain a printed sample report.
ERROR - Expired Barcode Check Time Date <ENTER>	Each measurement cassette and Standard Reference Cassette (SRC) is provided with a barcode label that must be read prior to insertion of the cassette into the analyzer. The barcode contains measurement information, lot number and expiration date. This message is displayed when the expiration date indicated in the barcode information has been exceeded. To resolve this error, first check analyzer time and date settings. If the settings are correct remove the SRC or measurement cassette and discard the expired cassette. Select an in-date cassette to perform the measurement.
ERROR - Possible Clot Discard Cassette <ESC>	During sample aspiration the SMC light gates LG1 and LG2 (LG3 for OPTI CCA) are used to detect proper sample aspiration. When LG1 detects sample has been aspirated at the beginning of the sensor path and LG2/LG3 fails to detect sample aspiration at the end of the sensor path, the warning of a possible clot is displayed.
ERROR - Invalid Sample Discard Cassette <ENTER>	In the OPTI-trol mode, a blood sample must be measured after the OPTI-trol measurement.

```
ERROR - Gas Expired
                    <ESC>
```

Each gas bottle is provided with a barcode label, which must be read prior to insertion of the gas bottle.
This message is displayed when the expiration date on the barcode has been exceeded.
First check whether the analyzer time/date setting is correct.
Then replace gas bottle with an in-date bottle (check expiration date on new bottle).
Note: The in-use expiration date may occur prior to the expiration date printed on the gas bottle label.

```
ERROR  -  No ID Entry
Edit Data<ENTER>or<ESC>
```

During analyzer setup, a selection can be made to require entry of patient ID and operator ID for each sample analyzed. If this function is selected, the analyzer will not report sample results, until a patient and/or operator ID is entered.

SYSTEM WARNING MESSAGES

```
WARNING - Low Gas
1 Test Remaining   <ESC>
```

The gas manifold assembly continually monitors gas pressure when the OPTI is in use. When the pressure is less than 25 psi, the **Low Gas** warning is displayed to indicate that the remaining gas pressure can perform only one additional sample measurement.

```
WARNING – Gas Expires
Soon!   Continue <ENTER>
```

The Gas expiration date is monitored based on the barcode that was swiped into the OPTI's memory at the time of the last gas canister change. This message alerts the operator that there is 2 weeks usage remaining for the gas tank. The operator can continue normal operation by pressing ENTER.

```
WARNING
No Sample Detected
```

The OPTI requires a minimum of 80µL (OPTI CCA 120µL) of blood or a minimum of 110µL (OPTI CCA 120µL) of clear fluid such as QC material to perform a measurement. Sample light gates LG1 and LG2/(LG3) in the sample measurement chamber (SMC) detect the leading and trailing edge of the sample in order to determine if the minimum amount of sample is aspirated. When LG1 does not detect sample aspiration, this message is displayed.

```
WARNING  -  Low Battery
1 Test Remaining   <ESC>
```

During battery operation of the analyzer, the OPTI continually monitors the battery voltage. When the operating voltage of the battery is less than 11.8 volts and greater than 11.2 volts a battery warning is displayed. This informs the operator to plug in the battery charger or install a fully charged battery prior to an interruption of system operation.

```
WARNING-Bad Sensor - pH
Continue<ENTER>or<ESC>
```

```
WARNING-Bad Sensor- CO2
Continue<ENTER>or<ESC>
```

```
WARNING-Bad Sensor - O2
Continue<ENTER>or<ESC>
```

```
WARNING-Bad Sensor- Na
Continue<ENTER>or<ESC>
```

```
WARNING-Bad Sensor - K
Continue<ENTER>or<ESC>
```

These warning messages indicate a single sensor has an output of less than 7,000 counts. The warning message may appear either during the calibration or sample measurement process. If this message occurs during sample measurement, check sample preparation. These warning messages are displayed and are specified for each measurement parameter. When this warning is displayed no sample measurement results will be reported for the parameter identified, however results will be reported for the other parameters.

```
WARNING -  Unstable pH
Check Cassette
```

```
WARNING - Unstable PCO2
Check Cassette
```

```
WARNING -  Unstable PO2
Check Cassette
```

```
WARNING - Unstable  Na
Check Cassette
```

```
WARNING -  Unstable  K
Check Cassette
```

This warning may be displayed during a calibration or measurement sequence and indicates a single sensor failed to reach an acceptable endpoint. The warning is displayed and indicates the sensor that does not reach endpoint in the right column of the display. If this warning occurs during sample analysis, check the cassette for air bubbles in the cassette upon the completion of the measurement sequence. If the warning is displayed during calibration, the parameter having the warning will not provide results.

```
WARNING- Bubble Detected
Check Cassette   <ENTER>
```

This message is displayed when the OPTI has detected an air bubble during sample aspiration. This message is displayed before the final results are displayed so the operator can be alerted to check the cassette for possible bubbles.
If an air bubble is sensed during sample aspiration, the aspiration routine is retried for up to 3 additional cycles. If all aspiration retries fail, the analyzer will display a **No Sample** Error. For a description of the aspiration cycle and bubble detect routine, refer to the "ERROR - No Sample" description.

```
WARNING - Check Pump
Continue <ENTER> or<ESC>
```

During a cassette calibration cycle, the peristaltic pump will pump calibration gas into the cassette. When the gas is being pumped into the cassette, the buffer in the cassette is pumped into the cassette reservoir. SMC light gates LG1 and LG2 are monitored during this time to detect the buffer evacuation in a precise time interval. If the light gates detect an improper evacuation of the buffer, the pump warning message is displayed.

```
WARNING  -  Check Pump
Please remove cassette
```

If pressing J twice to the above error message does not resolve the Check Pump condition, this message will be displayed.

```
WARNING - No PatID Entry
Continue         <ENTER>
```

```
WARNING - No Op ID Entry
Continue         <ENTER>
```

During analyzer setup and programming a selection can be made to require entry of a patient and/or operator ID for each sample analyzed. The analyzer will not report sample results until a patient and/or operator ID is entered. Enter the required ID to continue sample measurement.

```
WARNING - No ID Entry
Continue         <ENTER>
```

SYSTEM INFORMATION MESSAGES

No SRC Record (Level X)	When the operator has requested a printed report of the SRC measurement statistics and no records are stored in the SRC database this status message will be displayed. The displayed message also identifies the applicable SRC Level for which no SRC records exist.
SRC Database Deleted (Level X)	When the OPTI analyzer detects a new SRC ID, the operator is prompted to delete all current SRC data (password protected). As the operator enters the correct password and replies E to delete the SRC data, the analyzer prints the SRC statistical report and confirms deletion of the SRC data with this displayed message.
Please Wait Printing Stopped	While the OPTI internal thermal printer is printing a report, the operator may press E to abort printing. The analyzer will display this message until the current report is restarted or the operator presses E a second time to abort the print cycle.
Please Leave Cassette & Close the Cover	Following a sample measurement, the cassette reservoir is locked and the sample waste is sealed inside the cassette. This reservoir locking prevents the biohazardous waste from leaking and forms a sealed container for the sample waste. If the SMC Cover is opened prematurely in order to discard the cassette and the valve drive has not been turned to the locking position, this message is displayed. Close the cover and wait for the analyzer to prompt for cassette removal.
Terminate Operation: N Y	During an operating sequence of the OPTI, the operator may select to abort the current operation. To do this, press E and then "0". The analyzer then displays this message and waits for a key response (J or E)before terminating the current operation.

Not Enough Records (Level X)

The OPTI stores QC results and SRC results in an internal database. Cumulative statistics printed or displayed in the system software are calculated based on the stored data. A minimum of 2 data points is required in order to calculate statistical results. This message is displayed when too few records exist in the database to provide a result. Enter additional QC or SRC measurement data when this message is displayed.

Control Database Deleted (Level X)

When a new lot of QC material is to be run, the assay or package insert values must first be entered (under password control). As the operator enters a new lot number, the OPTI will prompt the operator to print and then delete the old QC data. As the QC records are deleted, this message is displayed to confirm the deletion of the QC database has occurred.

Operation: Halted ! Please Close the Cover

If the sample measurement chamber (SMC) cover is opened during a critical time (during calibration, aspiration or measurements), this message will be displayed. Close the SMC cover to continue normal operation.

New SRC Lot !

During an SRC measurement, the SRC ID number is checked by the barcode information. If the OPTI analyzer detects an ID number that differs from that of previous SRC measurements, the **New SRC** warning is displayed. The operator may select J to continue or E to exit the SRC measurement process.

Cassette Expired <ESC>

If an operator swipes a cassette barcode and the expiration date of the cassette has been exceeded, this message will be displayed. Check the analyzer TIME and DATE for the correct entry. If the time and date are correct replace the cassette lot with an in date lot.

Troubleshooting

The AVL OPTI provides display messages indicating the status of the analyzer. The previous section describes the conditions in which error, warning or system information messages may occur. This section contains troubleshooting tables to define possible causes and instructions for remedial action. In addition, troubleshooting flowcharts are provided for the most common error occurrences.

Error Message	Possible Causes	Remedial Action
WARNING -Low Battery 1 Test Remaining <ESC>	Battery voltage >11.2 and < 11.8 volts.	Replace battery pack with a fully charged battery. Plug in battery charger, check Charge LED is ON. The charger will charge a depleted battery while connected to AC power in approximately 6 hours. If the battery will no longer accept a charge replace the battery with a new battery pack. Check the charge LED status; a solid ON indicates the battery is charging, a fast flashing ON LED (4 times/second) indicates battery is fully charged. If the charge LED is OFF this indicates the charger is not connected. Replace charger or replace the main board. A slow flash (1 flash per second) indicates the battery voltage is below 9.5 volts or the battery thermistor senses an excessively hot or cold battery. Replace the battery if this indication persists.

Error Message	Possible Causes	Remedial Action
STOP - Low Battery Recharge Now	Battery voltage <11.2 volts and the analyzer will stop operating.	See above troubleshooting hints. When the battery voltage rises above 11.2 volts the analyzer will resume operation.
STOP - Low Battery Recharge and Cycle Power	Battery voltage drops below 10.5 V.	Connect power supply and cycle power.
STOP - System Error Cycle Power for Reset	At power-up software is not initialized correctly.	Turn power OFF and ON to retry. Check interconnect cables for a secure connection. Perform system initialization. Replace SMC module. Replace main board.
STOP - Temp Out of Range Please Wait Menu <Enter>	SMC top plate temperature T1 must be 37.00° C ±0.05 and bottom plate T2 must be 37.15° C ±0.05.	Check fuse F2. Perform Temperature Diagnostic check to determine current temperature. Perform Temperature circuit adjustment. Install SW Version ≥ 1.10 Replace SMC module Replace main board. Replace heater board in SMC cover.

Error Message	Possible Causes	Remedial Action
WARNING - Low Gas 1 Test Remaining	The gas cylinder is near empty and has only enough pressure to perform one additional measurement.	Replace gas cylinder with a full cylinder. Replace gas module assembly.
STOP - Low Gas Replace Now <ESC>	The pressure of the gas cylinder is empty. No measurements can be made.	See troubleshooting hints above.
STOP - Memory Error Database Deleted <ESC>	RAM data has been changed, corrupted, or lost, or a new software version has been installed	Press ESC and all factory settings will be copied from EEPROM to RAM.
ERROR - Invalid Barcode Continue <ENTER>	During barcode swipe, the read barcode information is not in the correct format (i.e. SRC barcode is swiped for a normal measurement).	Check the correct menu is selected. Select a cassette barcode and swipe to determine barcode function. Perform barcode diagnostic test. Perform system initialization. Check barcode format is supported by the OPTI. Clean barcode lens. Replace internal or external barcode assembly. Replace main board.
ERROR - Invalid Barcode Check Time/Date <ENTER>	The expiration date does not match the current date setting	Check correct Time/Date setting

Error Message	Possible Causes	Remedial Action
STOP - Need New SRC Data Must run SRC's <ESC>	If QC lockout has been selected to require daily SRC measurement, SRC's must be run at least once per day.	Run required SRC daily measurements.
STOP - New Cassette Lot Must Run Controls <ESC>	New Lot has been selected in QC Lockout and a new lot of cassettes was detected. The new lot of cassettes must be verified with quality control material.	Select a cassette from the current lot and run measurement. Run QC material to verify the new lot of cassettes.
ERROR - Cassette Misseat 1 Reinsert or <ESC>	Top cover light gates LT1 and LT2 detect a cassette not seated properly.	Open cover and reposition the cassette. Retry with new cassette. Perform LED test in system Diagnostics. Replace SMC cover.
ERROR - Cassette Misseat 2 Reinsert or <ESC>	During displacement of buffer, the rear light gate LG2 fails to detect a transition from buffer to air.	Open cover and reposition the cassette. Retry. Discard cassette and retry with a new cassette. Replace SMC seal. Perform flowtest. Check pump cartridge is seated correctly, replace if necessary. Check valve drive position. Check for adequate gas flow

Error Message	Possible Causes	Remedial Action
ERROR - Cassette Misseat 2 Discard Cassette <ESC>	If above error occurs repeatedly, this message is displayed.	Discard cassette.
ERROR - Bad Sensors Discard Cassette <ESC>	During a cassette calibration, the optode sensors did not have sufficient signal output.	Check cassette foil pouch for tears or leaks. Make sure cassette pouch was opened within 10 minutes from start of measurement. Clean glass optics plate. Try a new cassette.
ERROR - Bad Calibration Discard Cassette <ESC>	Two or more sensors failed to reach endpoint during calibration cycle.	Discard cassette and retry with a new cassette. Check for leaks in fluidic tubing. Check for proper seating of pump cartridge.
ERROR - Unstable Sensors Discard Cassette	Sample preparation or sample with high or extreme measurement characteristics.	Check cassette for air bubbles or voids over sensors. Thoroughly mix sample prior to measurement.
ERROR - Expired Barcode Check Time/Date <ENTER>	Cassette date code has expired.	Use cassette with an in-date expiration. Check for current date and time.
ERROR - Bad Cassette Discard Cassette <ESC>	Cassette optics characteristics failed during cassette check.	Check cassette foil pouch for leaks or tears.

Error Message	Possible Causes	Remedial Action
		Make sure cassette pouch was opened within 10 minutes from start of measurement. Discard cassette.
ERROR - Cal Expired Discard Cassette <ESC>	After calibration of the cassette a sample must be run within 10 minutes. If no sample is entered, the analyzer will perform another calibration. This process will be repeated for up to 30 minutes, then the cassette must be discarded. OPTI CCA calibrations expire After the first 10 minute period.	Run a sample measurement within 30 minutes after cassette insertion. Open a new cassette and retry.
ERROR - Dirty Optics Clean Cass./Optics <ESC>	Sample light gates LG1 and LG 2 fail to calibrate. SMC Optics may have become dirty with blood residual.	Wipe residual from cassette prior to insertion. Clean glass optics plate. Discard cassette and try new cassette. Perform Diagnostic LED Test. Make sure green LED's in SMC cover light up. Replace SMC cover.
ERROR - Gas Expired <ESC>	Gas bottle barcode expired. In-use life expired. Instrument time/date setting incorrect.	Replace with new gas bottle. Set correct time/date.

Error Message	Possible Causes	Remedial Action
ERROR - No Pat. ID Entry Edit Data <ENTER> or <ESC>	Patient ID is selected as a required entry for all measurements.	Press <ENTER> to continue and enter a Patient ID for the sample. Results will be displayed and will not be printed until an ID has been entered.
ERROR - No Op. ID Entry Edit Data <ENTER> or <ESC>	Operator ID is selected as a required entry for all measurements.	Press <ENTER> to continue and enter an Operator ID for the sample. Results will be displayed and will not be printed until an ID has been entered.
ERROR - No ID Entry Edit Data <ENTER> or <ESC>	Patient and operator ID was selected as a required entry for all measurements.	Press <ENTER> to continue and enter an operator and patient ID for sample results.
WARNING - Bubble Detected Check Cassette	LG 1 detected sample aspiration and detected air prior to sample reaching LG 2.	Check cassette for air bubbles or insufficient sample volume.
ERROR Possible Clot Discard cassette <ESC>	LG 1 detected sample aspiration and analyzer timed out before sample reached LG 2.	Check sample cassette for clots. Run properly heparinized sample. Check peri pump cartridge and replace as necessary.
ERROR - Invalid Sample Discard Cassette <ENTER>	During OPTI-trol measurement, the sample detected was not a blood sample.	Measure a blood sample after OPTI-trol measurement.
WARNING Bad Sensor - pH Continue <ENTER> or <ESC> WARNING Bad Sensor– PCO2	Air bubbles in cassette or void over sensor. Possible poor sample preparation or corrupt optics giving < 7,000 counts.	Check for air bubbles in cassette. Remix sample and rerun with new cassette.

Error Message	Possible Causes	Remedial Action
WARNING Bad Sensor – PO2 WARNING Bad Sensor – Na WARNING Bad Sensor – K		Cycle analyzer power. Open SMC cover and check operation of Blue LED's. Replace the SMC Assembly.
WARNING - Unstable pH Check Cassette WARNING - Unstable PCO2 WARNING - Unstable PO2 WARNING - Unstable Na WARNING - Unstable K	Possible poor sample preparation or air bubbles in cassette.	Check for air bubbles in cassette. Remix sample and rerun with new cassette.
WARNING – Gas Expires Soon!	Press YES to Continue	Gas will expire in two weeks.
WARNING - No Pat. ID Entry Continue <ENTER>	Patient ID is selected as a required entry	Press <ENTER> to continue and enter a Patient ID
WARNING - No Op ID Entry Continue <ENTER>	Operator ID is selected as required entry	Press <ENTER> to continue and enter an Operator ID
WARNING - No ID Entry Continue <ENTER>	Patient and operator ID is selected as required entry.	Press <ENTER> to continue and enter a patient and operator ID.
WARNING No Sample Detected	Analyzer timed out before sample was detected by LG 1.	Reposition sample device and rerun sample.

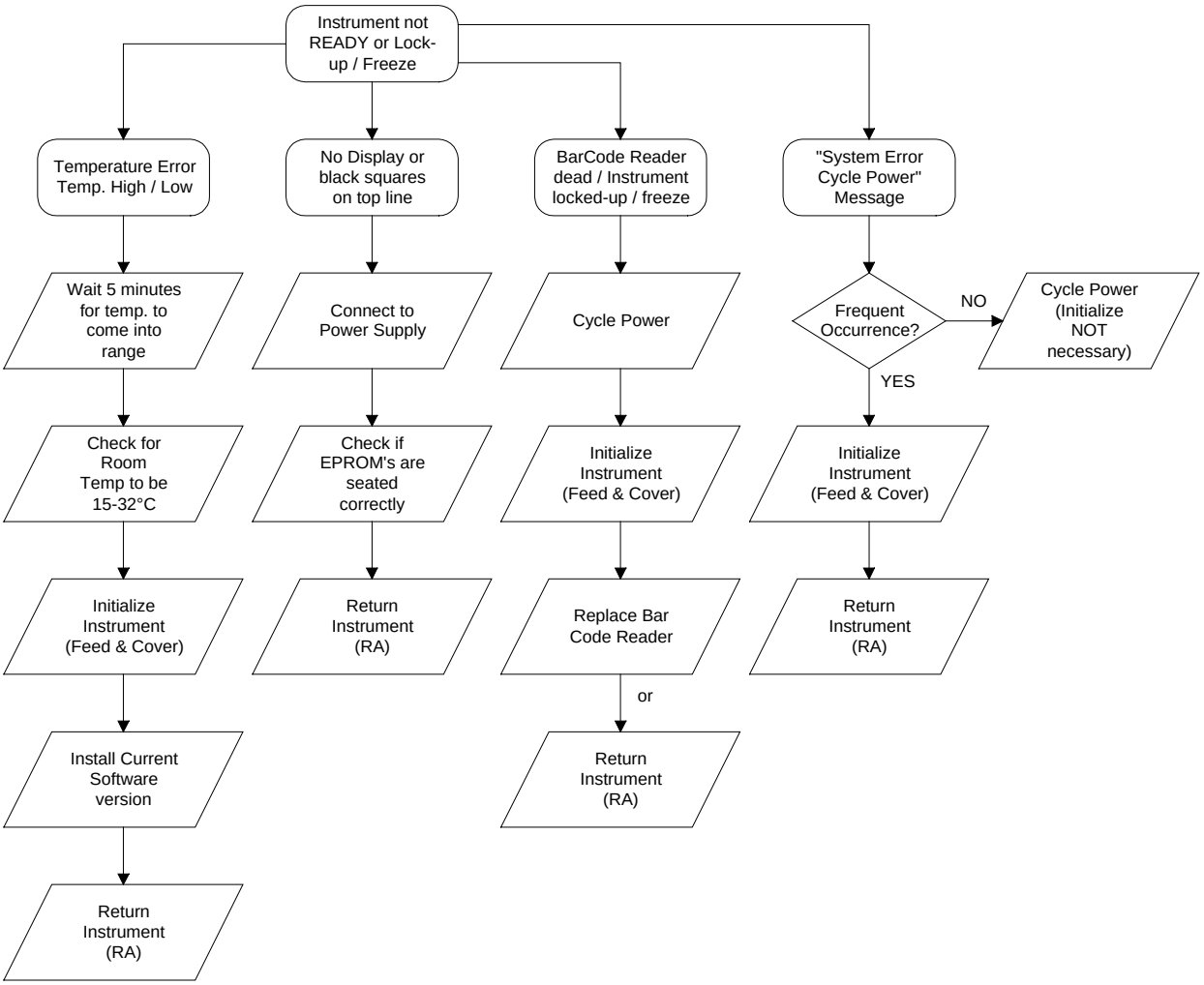
Error Message	Possible Causes	Remedial Action
WARNING - Check Pump Continue <ENTER> or <ESC>	LG1 and LG2 detected improper movement of buffer within cassette.	Open SMC and reseat cassette. Perform Flow Test in system diagnostics. Replace Pump Cartridge and seals. Check tubing for leaks.
WARNING - Check Pump Please remove cassette	If above message occurs repeatedly, this message is displayed.	Replace cassette.
No Display or power to analyzer	LCD display does not indicate analyzer operation.	Check if EPROM's are seated properly. Check fuses F1 and F3. Check for proper battery/charger power. Replace main board. Check cable connections.
Excessive use of gas	Possible leak in gas path.	Check for proper sealing of pump cartridge. Check for leak in tubing or tubing not connected. Clean seal in gas module assembly. Replace gas module.

Error Message	Possible Causes	Remedial Action
New SRC Lot!	A new SRC is being run and has not been previously measured.	Print and delete previous SRC data prior to measuring new SRC.
Printer does not print	Possible printer paper jam or malfunction.	Check paper supply. Check printer for paper jams. Check printer cables for secure fit. Replace printer. Replace main board.
SRC's fail	Possible problem with OPTI measurement system or SRC.	If only one SRC is failing, run QC samples. If QC is OK, replace SRC. If all SRC's are failing, reset unit and repeat measurements. Open the SMC cover. Verify three blue LED's are visible and steady. If not, replace the SMC cover. Replace the SMC module.

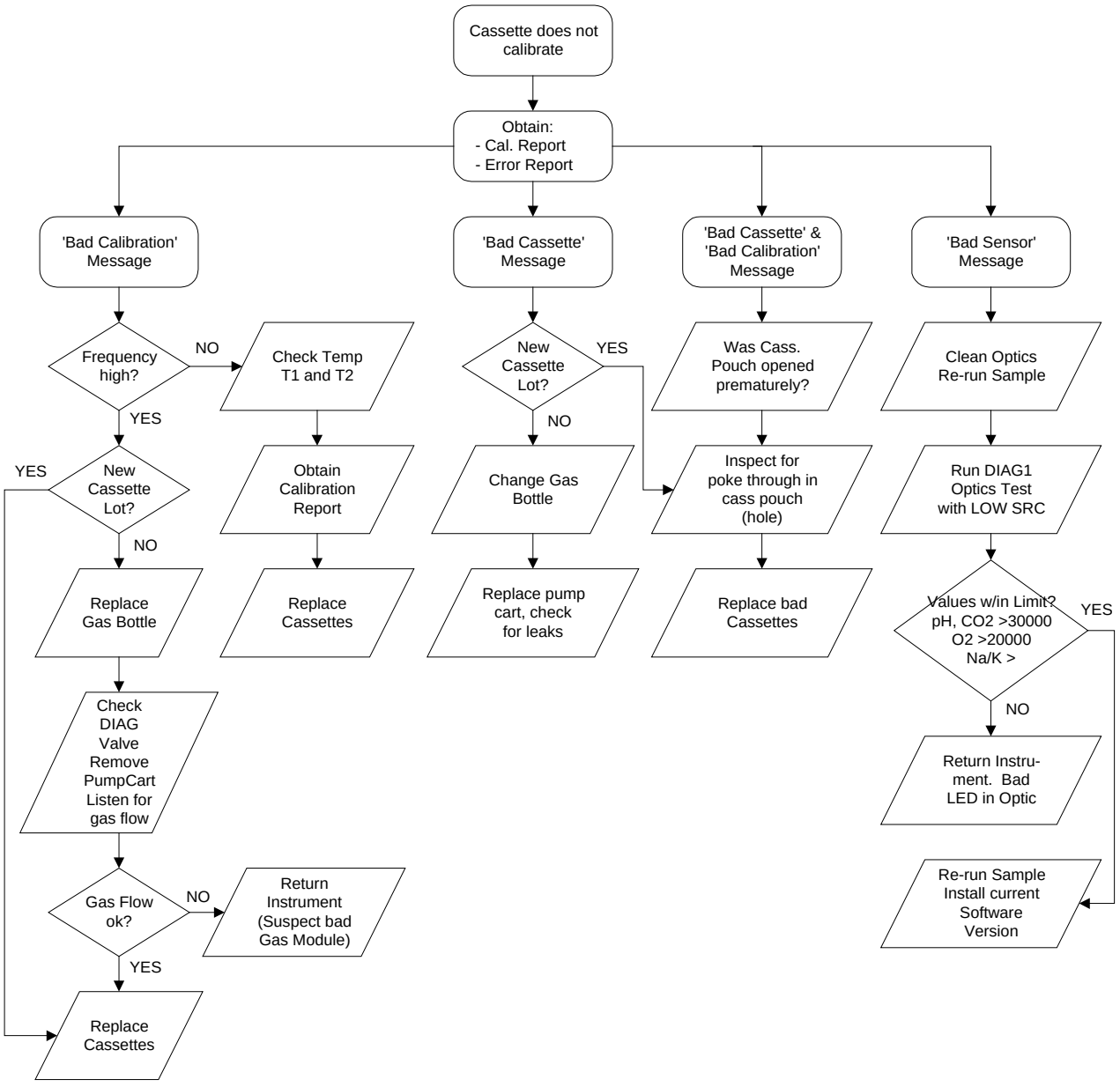
Error Message	Possible Causes	Remedial Action
QC out of range	Possible problem with OPTI measurement system.	Repeat QC measurement with new cassette ensuring that the cassette is wiped dry prior to measurement. If PCO_2 or PO_2 values are out, check the cassette for air bubbles or voids. Verify that the QC vial is not too warm or too cool before performing measurement. Replace calibration gas bottle.

Troubleshooting Flowcharts

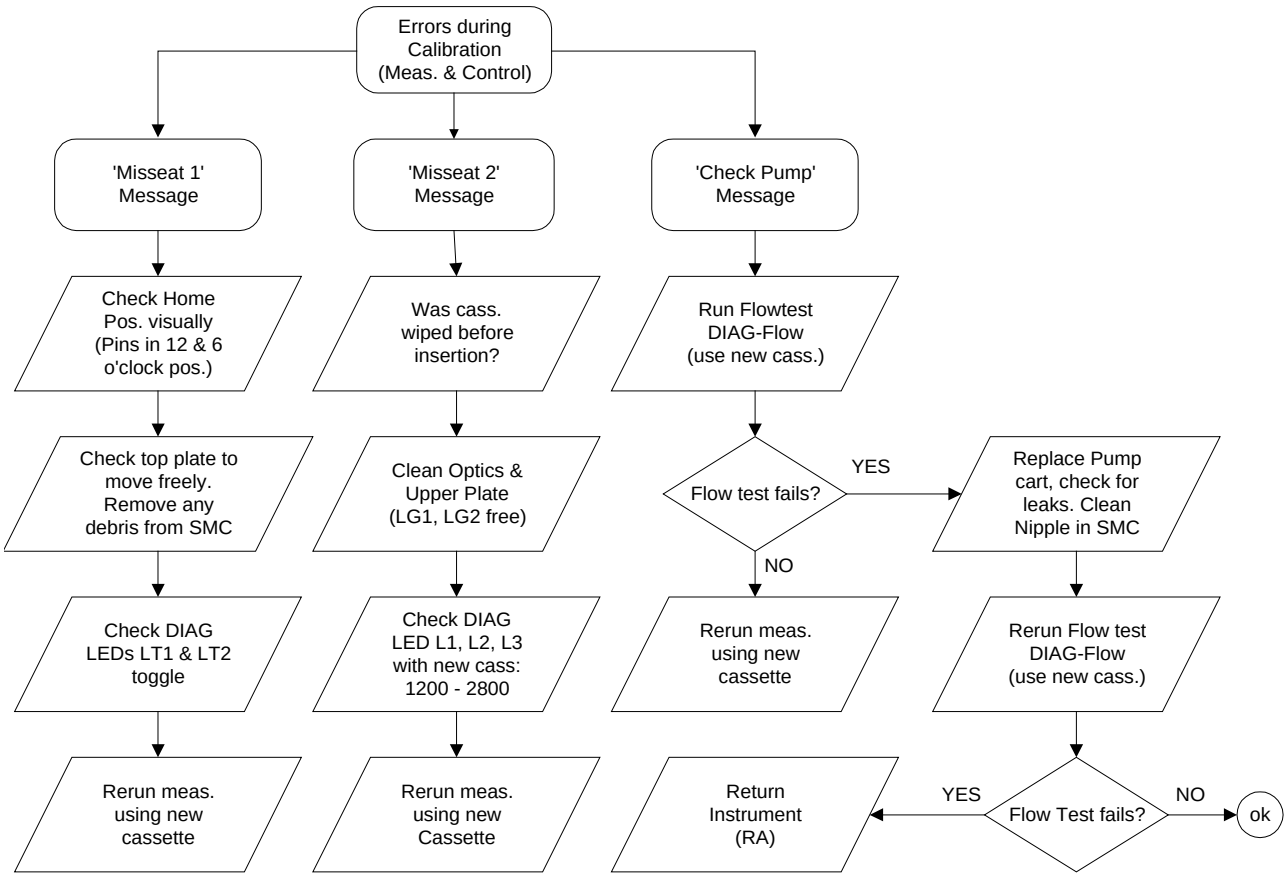
Opti Troubleshooting - 1



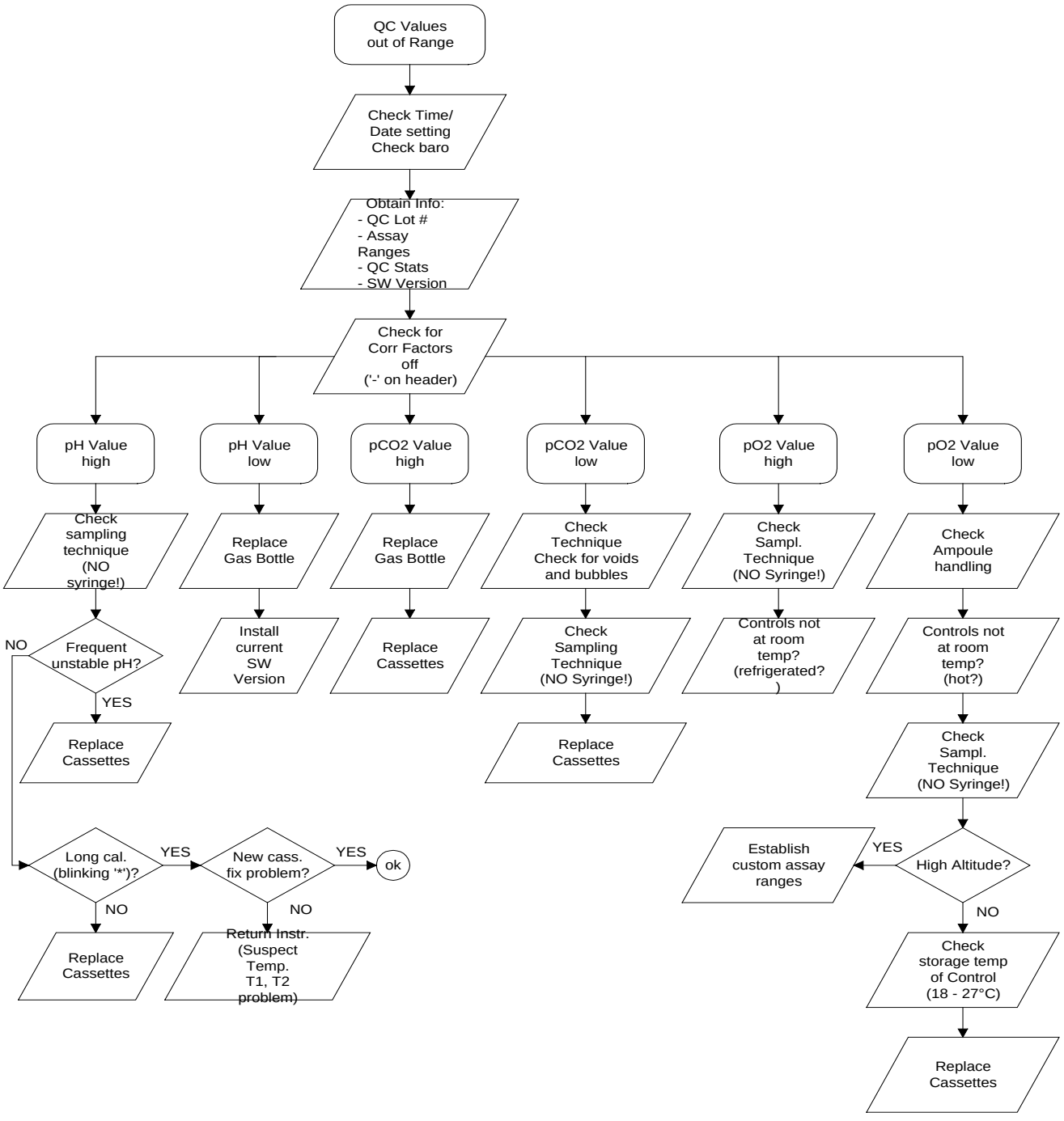
OPTI Troubleshooting - 2



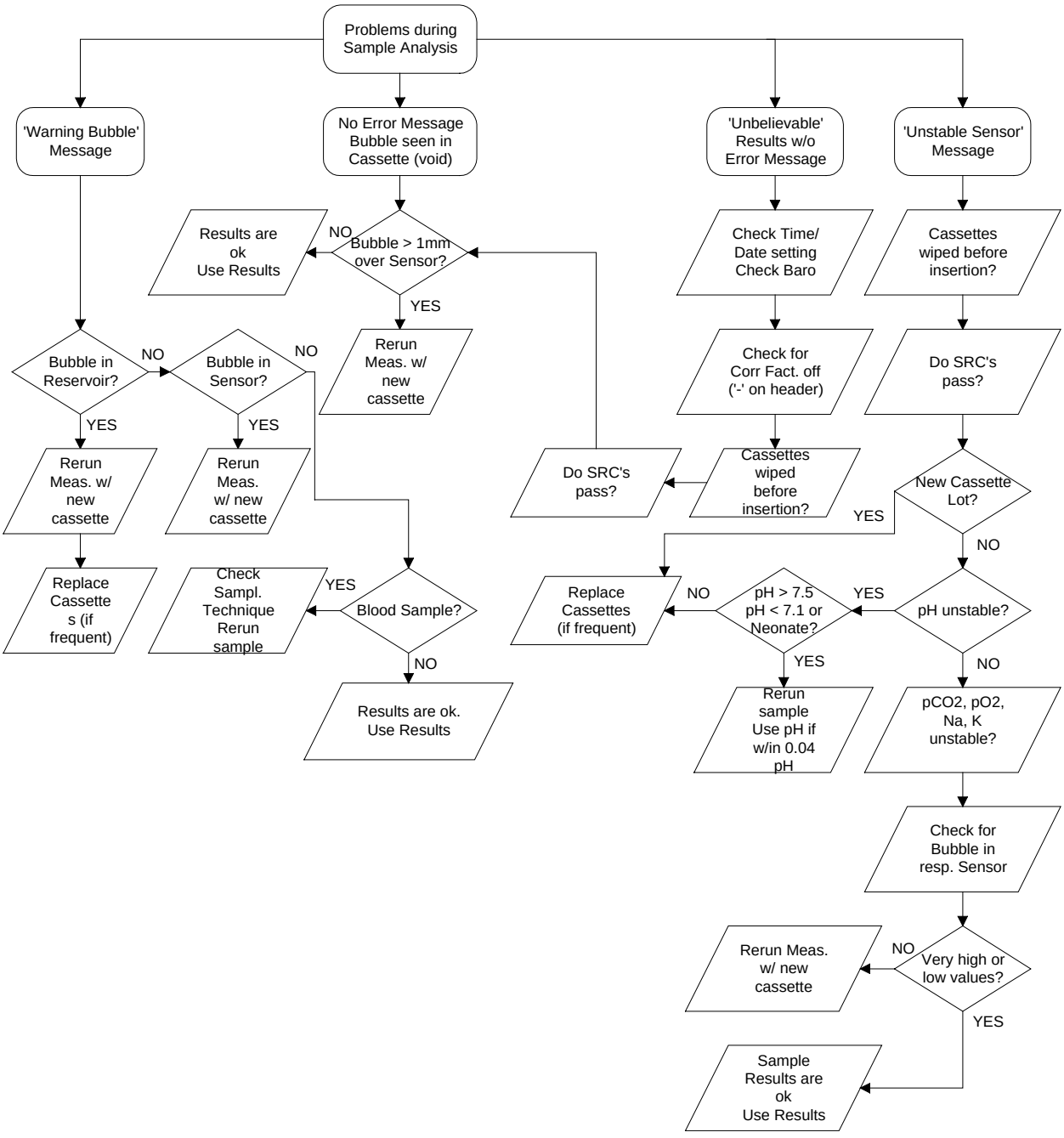
OPTI Troubleshooting - 3



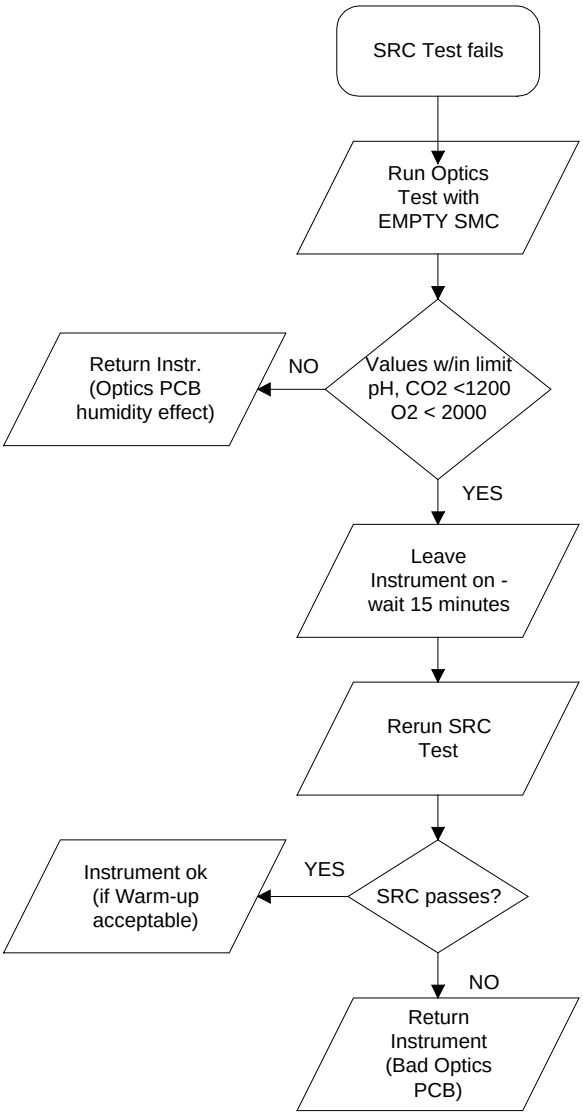
OPTI Troubleshooting - 4



OPTI Troubleshooting - 5



OPTI Troubleshooting - 6



9 Electronic Diagrams

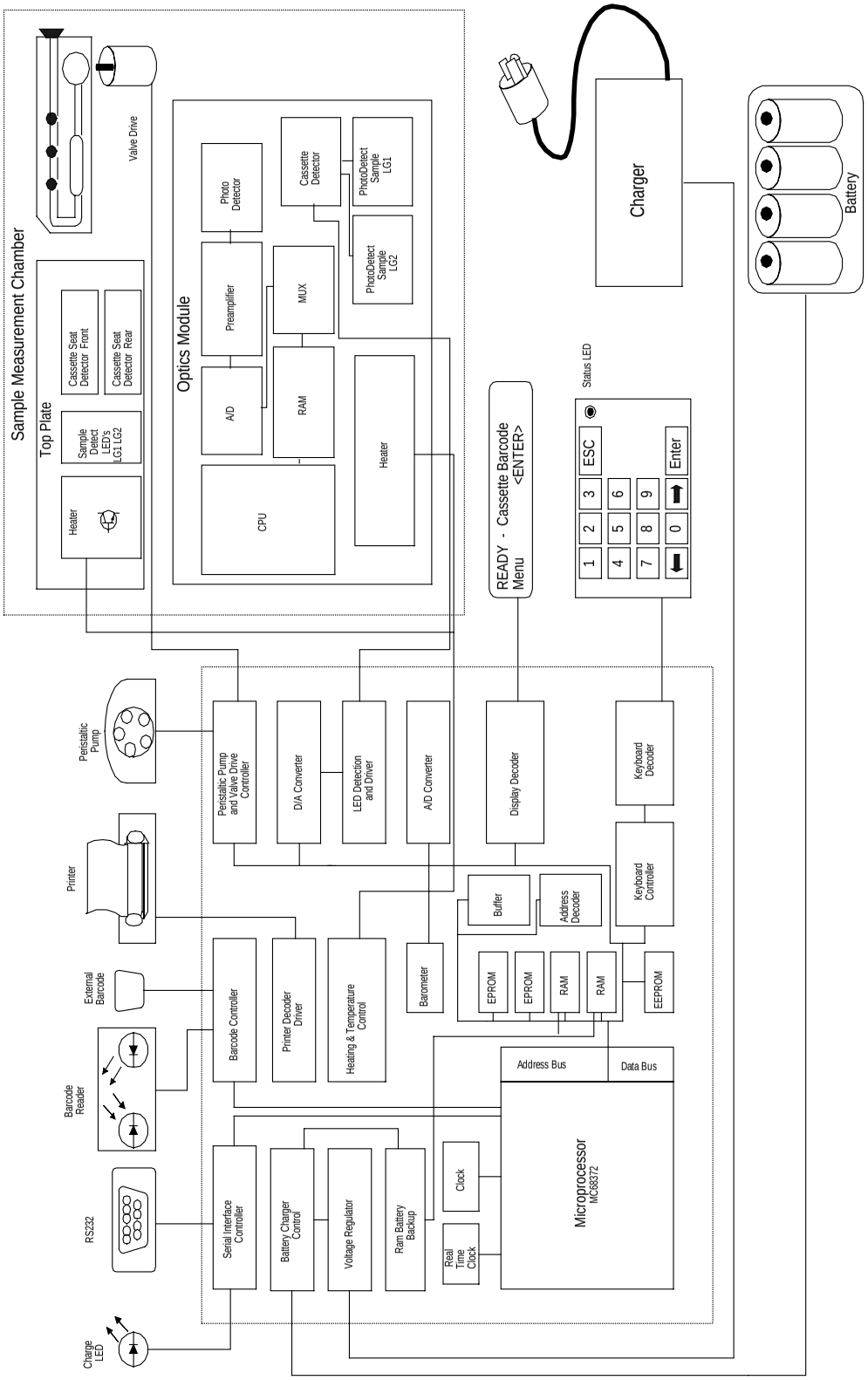
OPTI 1 System

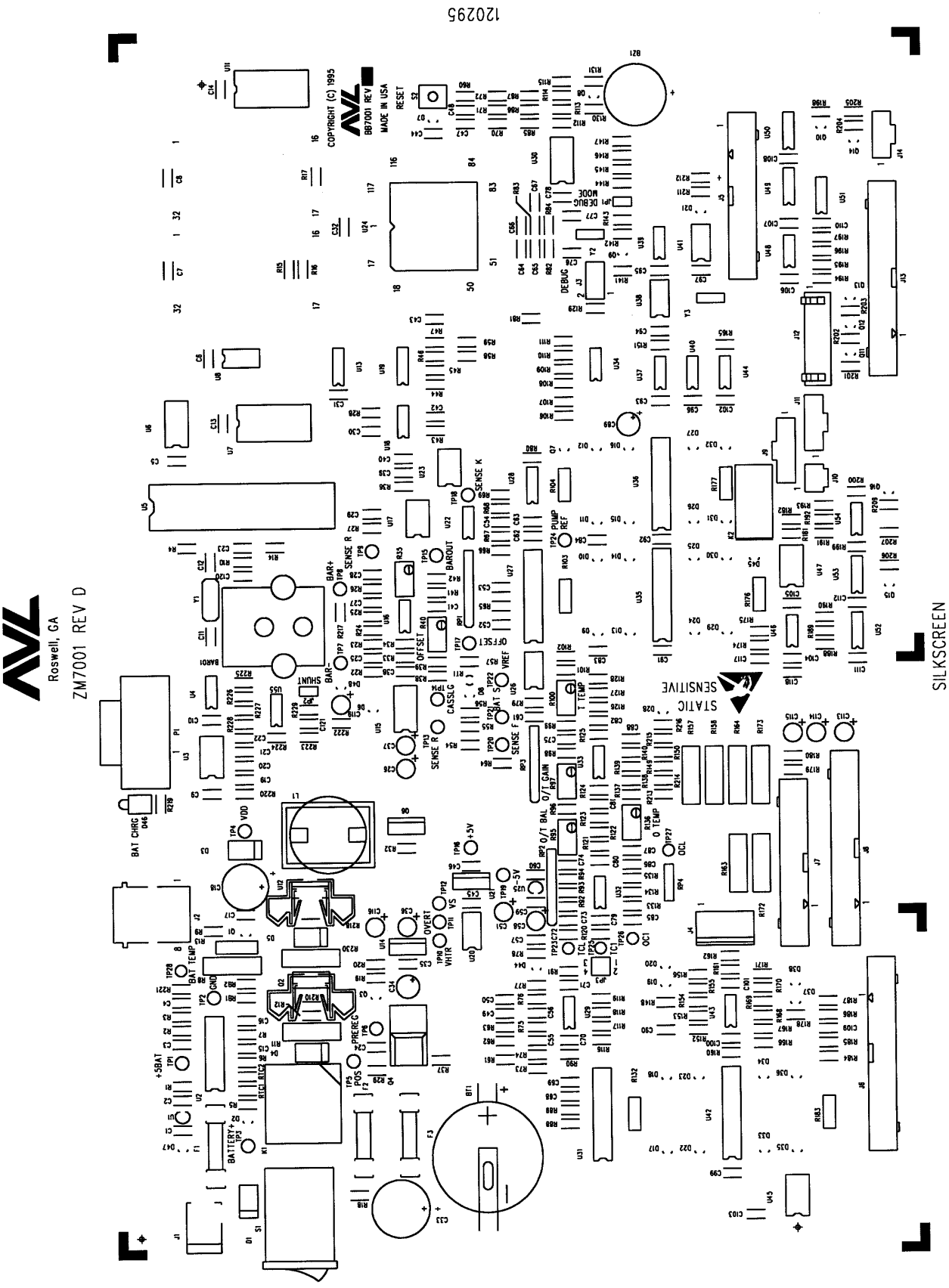
The system electronic diagrams are included to provide service personnel a reference for tracing system signals when troubleshooting the OPTI 1 system. The electronic diagrams have been divided into sections to accommodate standard paper sizes. Each diagram provides signal labels which indicate input and output signals for that section of the circuitry. In addition to the signal labels, numbers are provided at each signal label indicating the appropriate diagram sheet number where that signal is connected. This is done to easily locate signal interconnection throughout each section of the electronic diagram.

For the OPTI Main Board, there are 21 electronic diagram sections included within the service manual. Sheet one contains a system block diagram. This sheet is included to provide service personnel a reference for the overall system main signals and assembly interconnections.

OPTI 1 - System Block Diagram

Sheet 1




120295
Roswell, GA
ZM7001 REV D
SILKSCREEN
SENSITIVE
STATIC
COPYRIGHT (C) 1995
MADE IN USA
RESET
DEBUG
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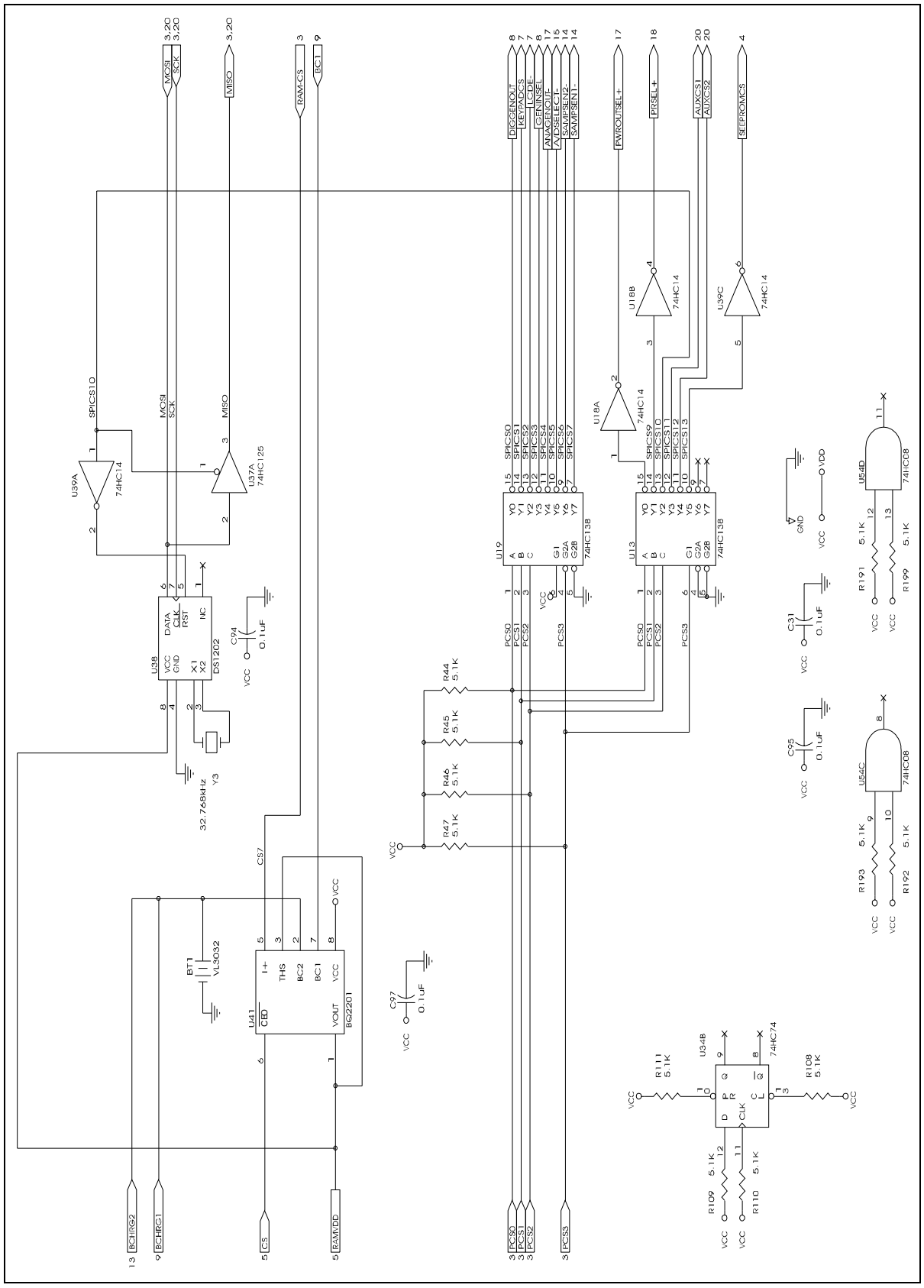
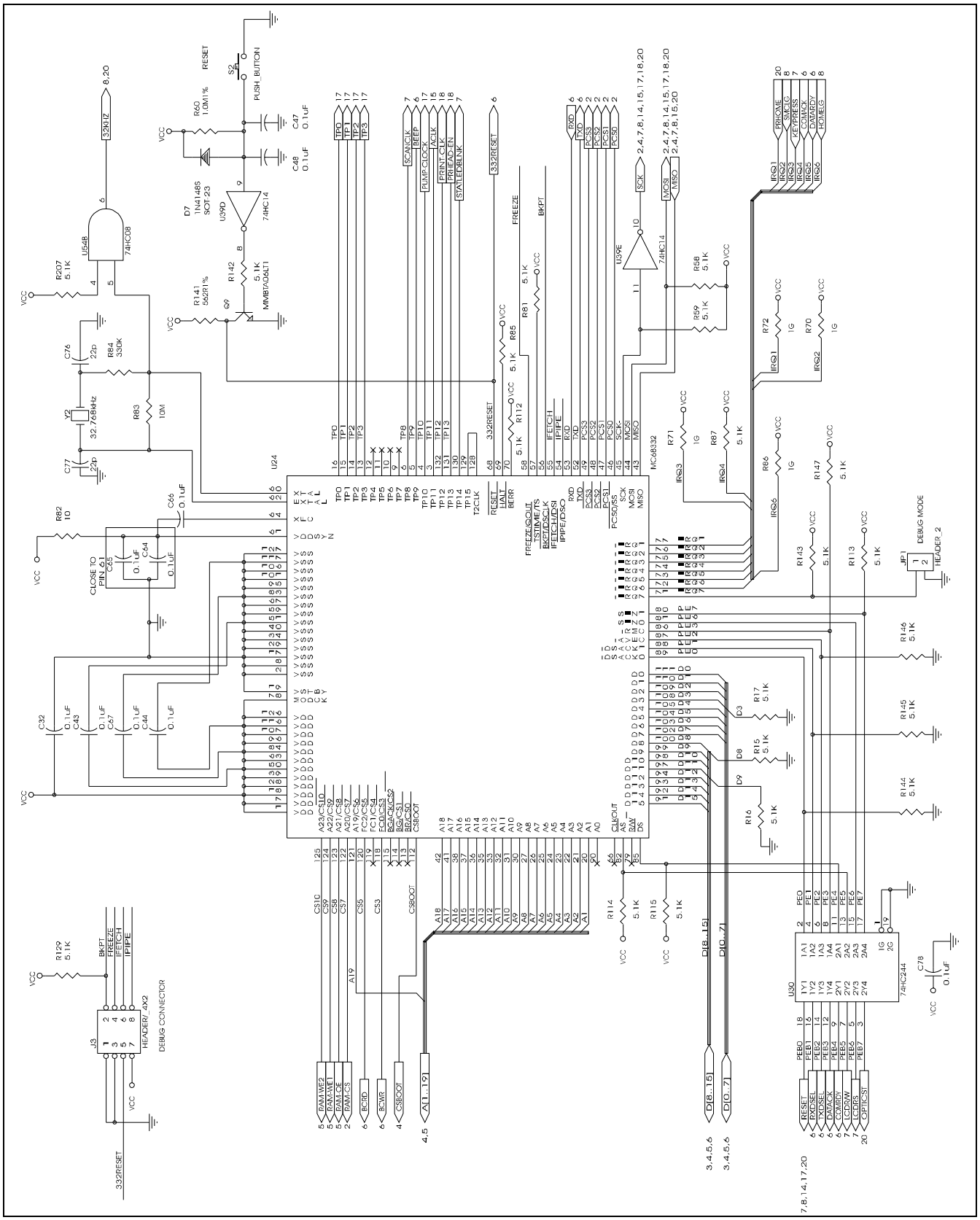
BAT CHRG
BAT TEMP
+5BAT
BATTERY
PREREG
VDD
+5V
-5V
VS
VHTR
OVERT
OCL
OCI
O TEMP
T TEMP
O/T GAIN
O/T BAL
SENSE K
SENSE R
SENSE F
BAROUT
OFFSET
VREF
PUMP REF
CASSLG
BAT S
BAR+
BAR-

MAIN BOARD - RAM Battery Backup/Clock Sheet 3



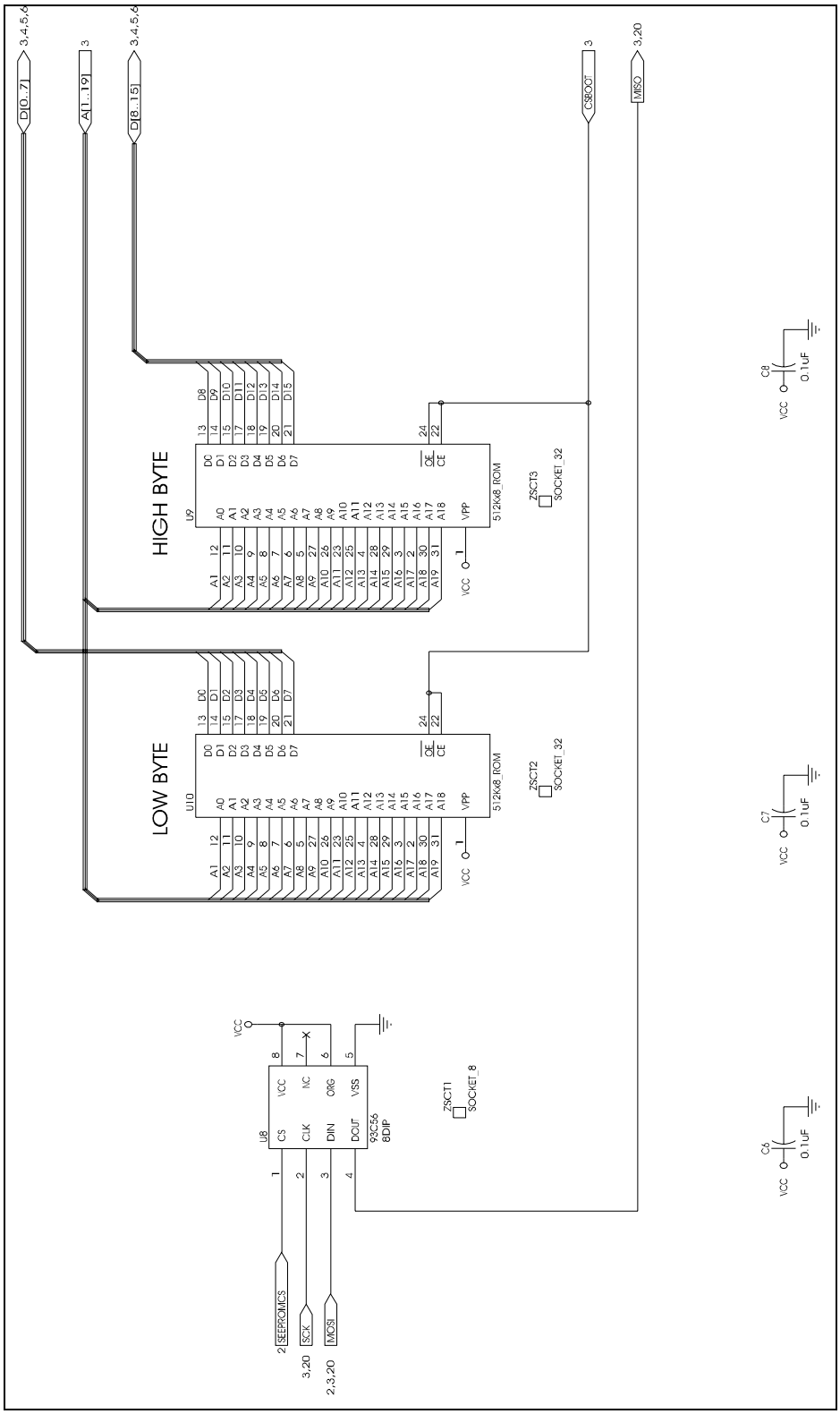
MAIN BOARD - Microprocessor Circuit

Sheet 4



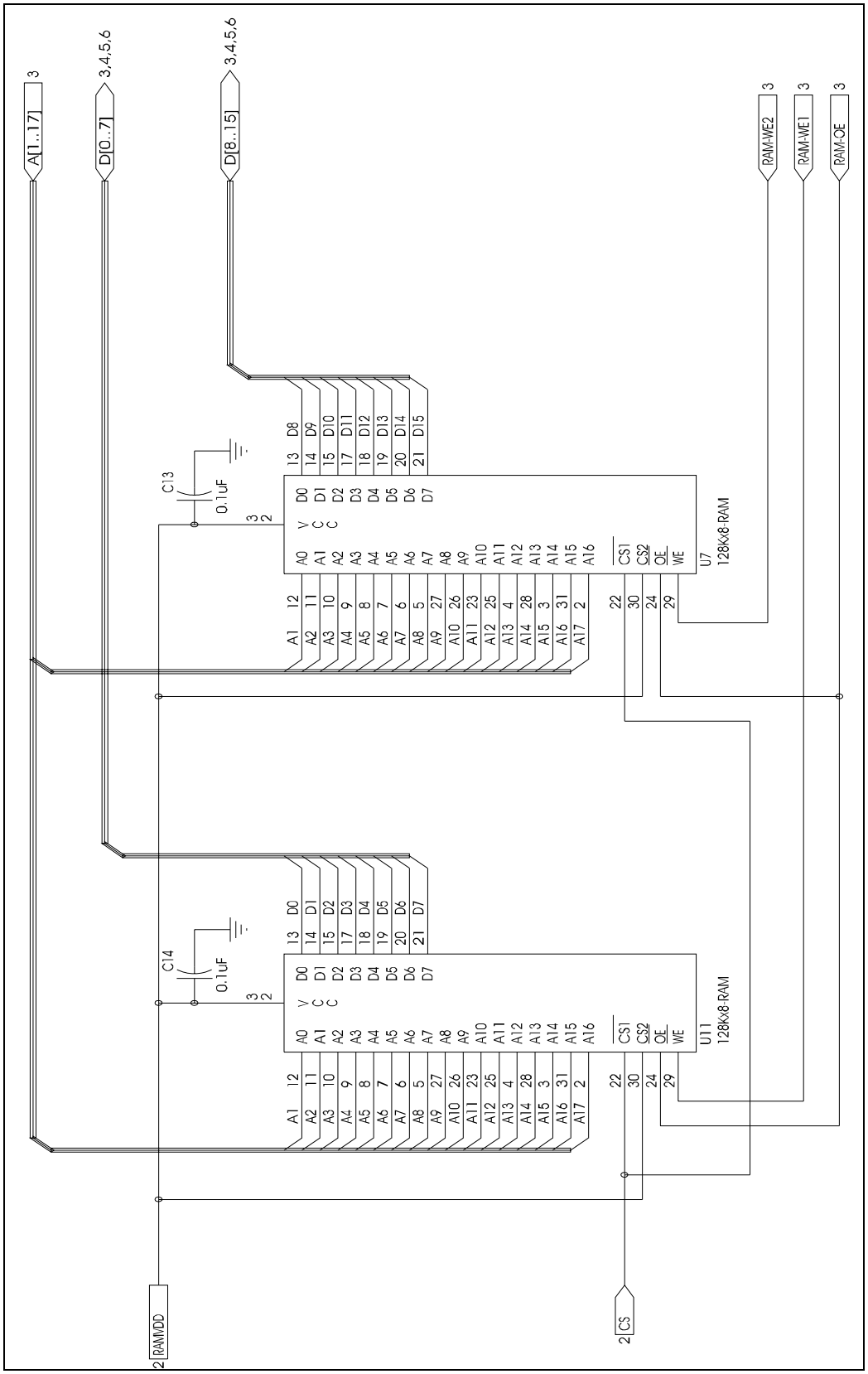
MAIN BOARD - 16 Bit EPROM Circuit

Sheet 5

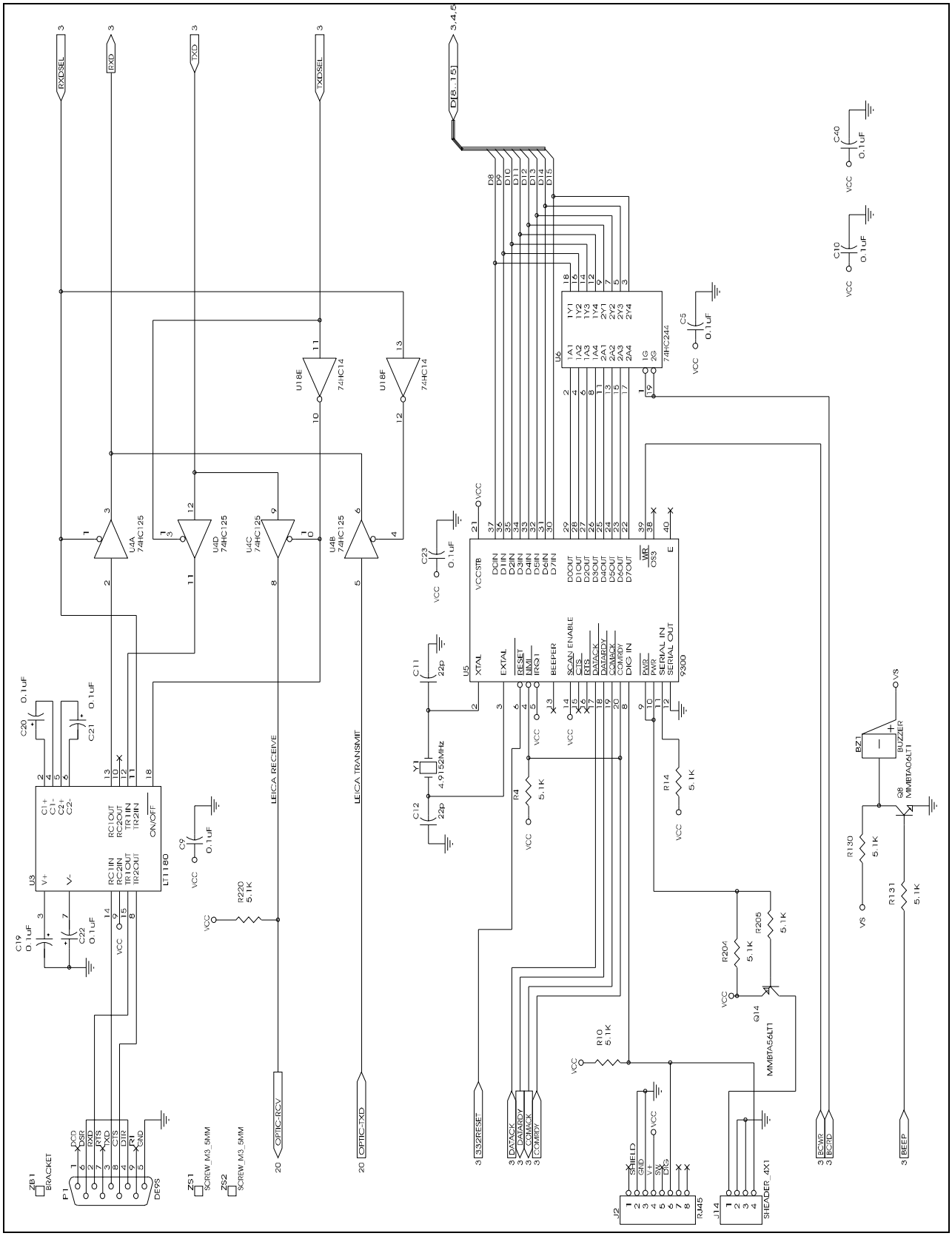


MAIN BOARD - 16 Bit RAM Circuit

Sheet 6

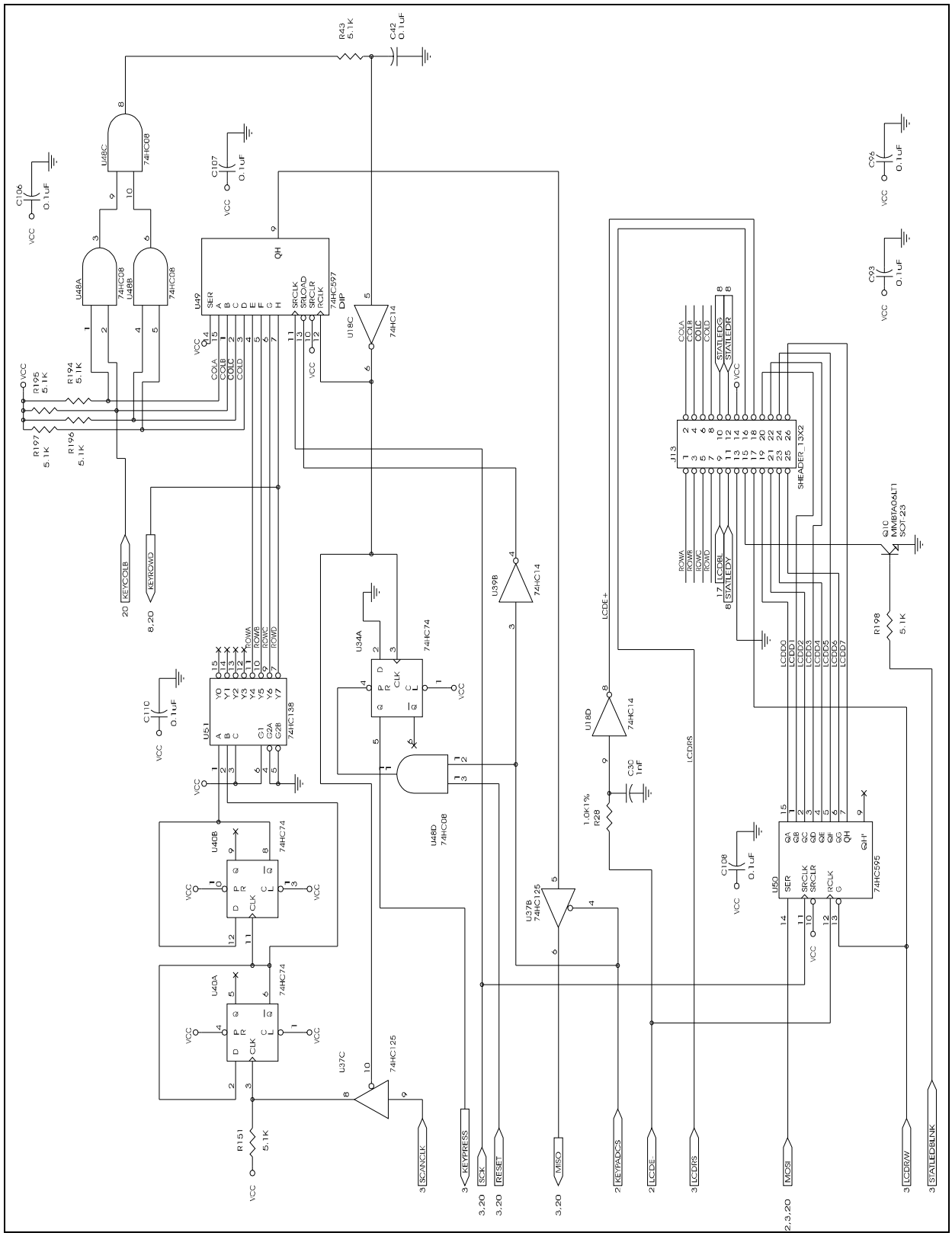


MAIN BOARD - Barcode and Serial Interface Circuit Sheet 7

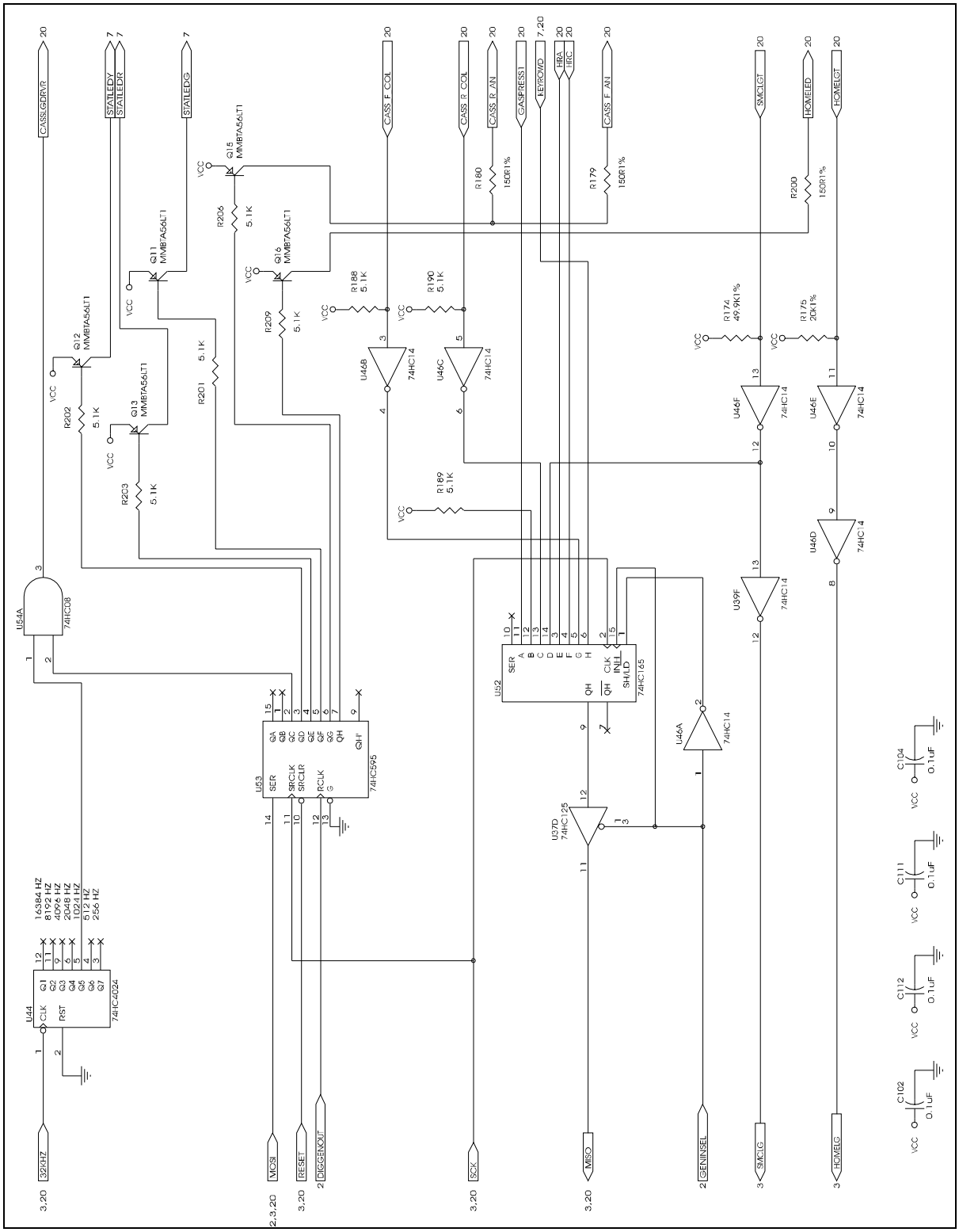


MAIN BOARD - Keypad and Display Circuit

Sheet 8

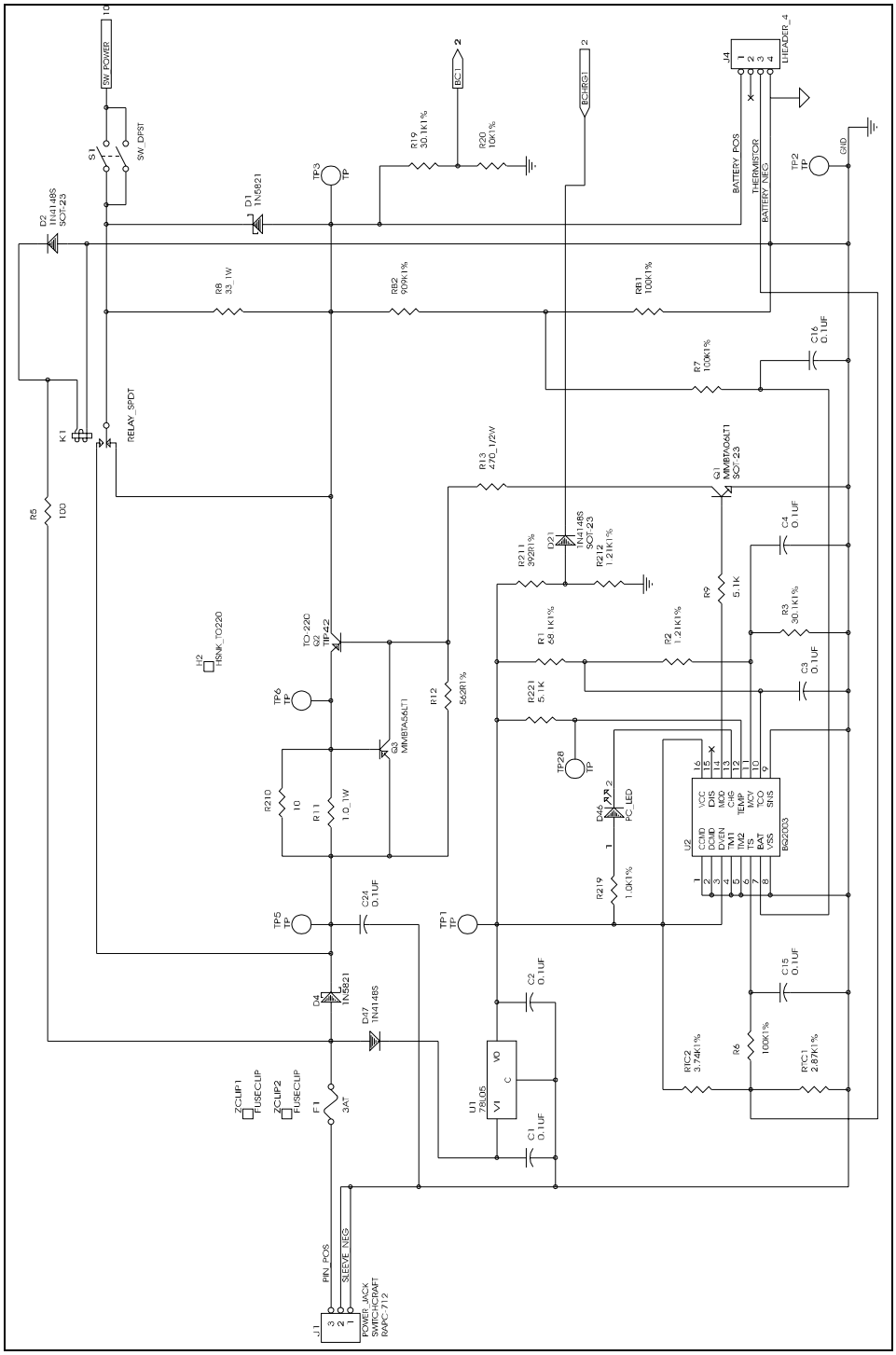


MAIN BOARD - Cassette Detection Logic Circuit Sheet 9



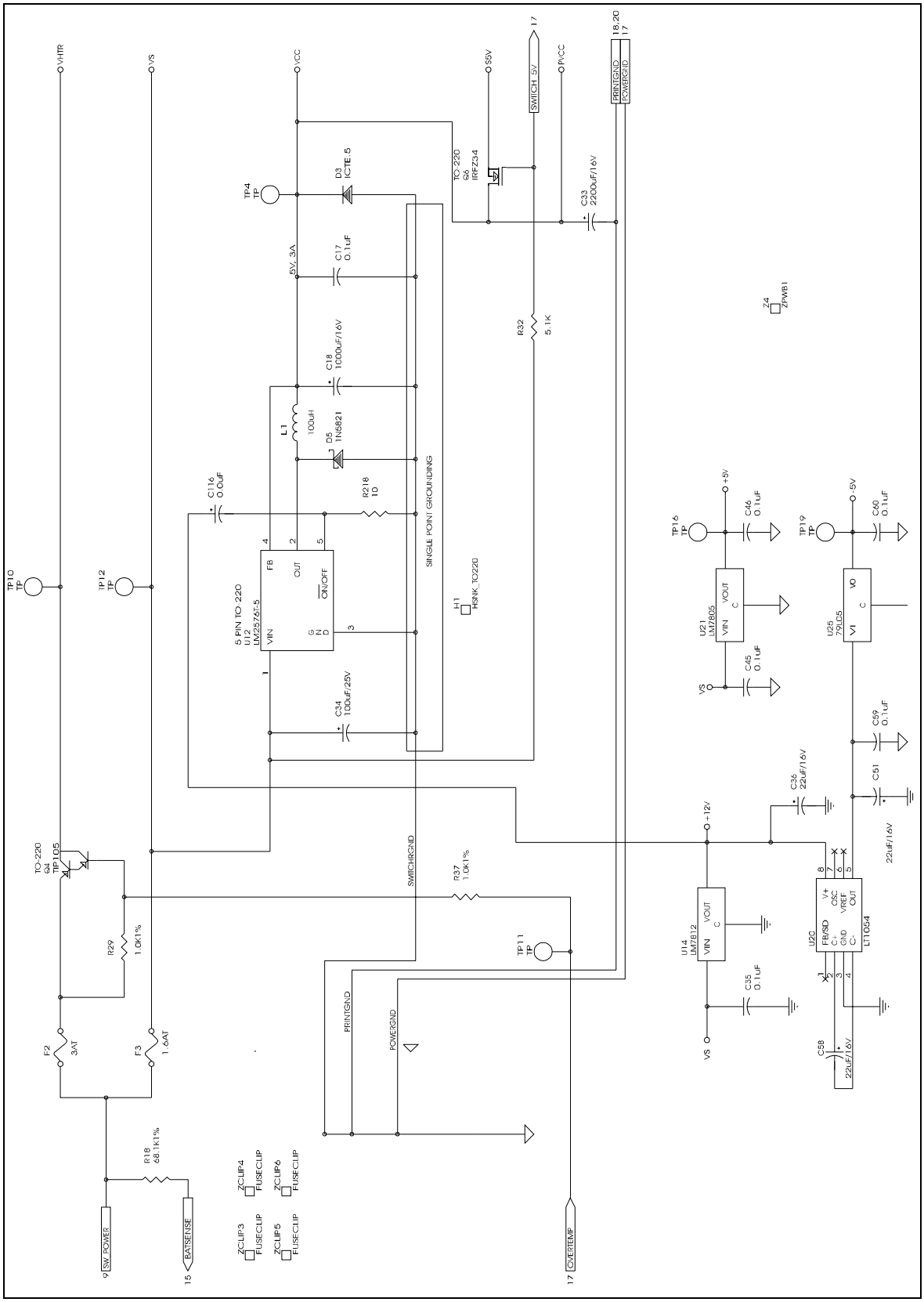
MAIN BOARD - Battery Charger Circuit

Sheet 10

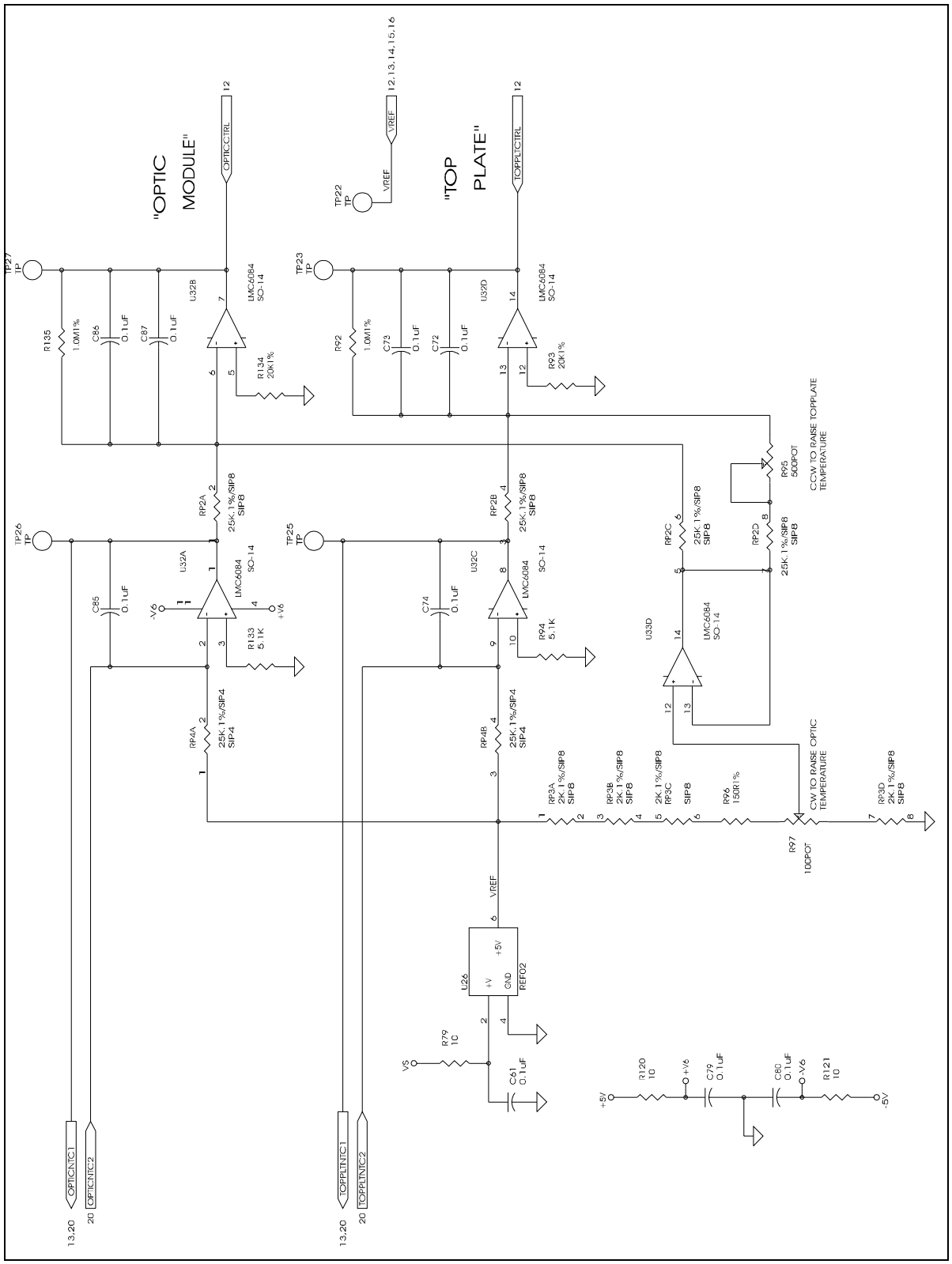


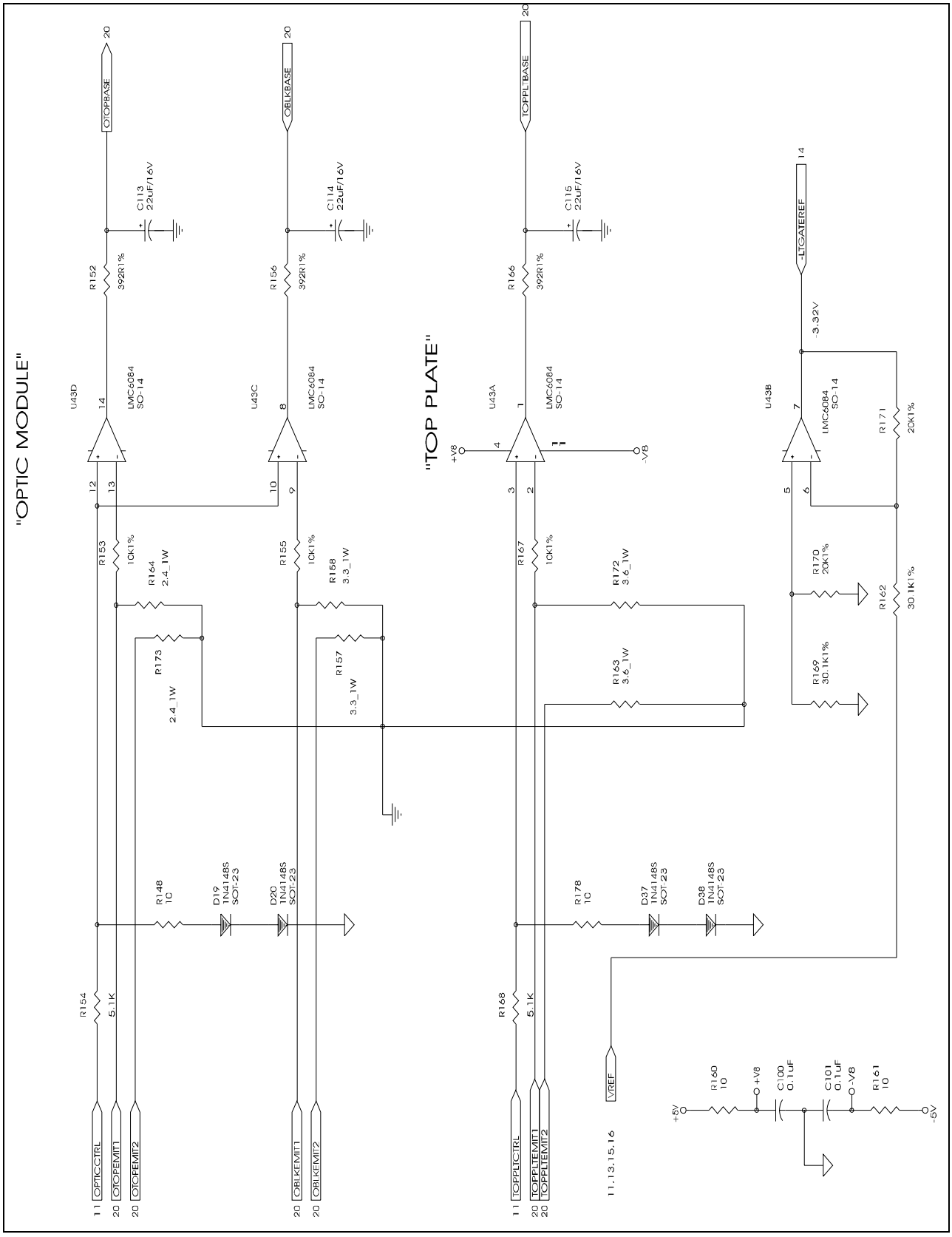
MAIN BOARD - Voltage Regulator Circuit

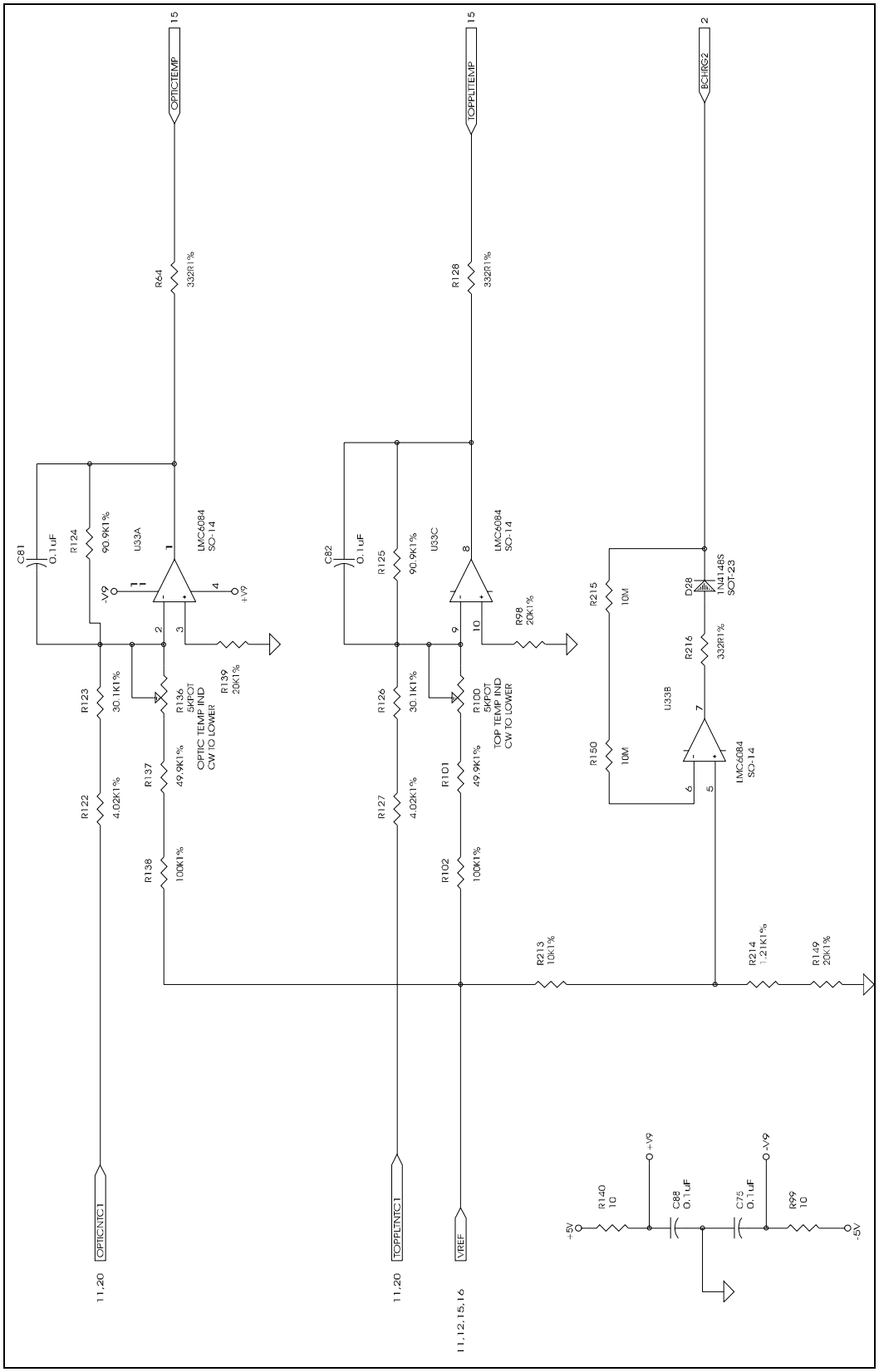
Sheet 11

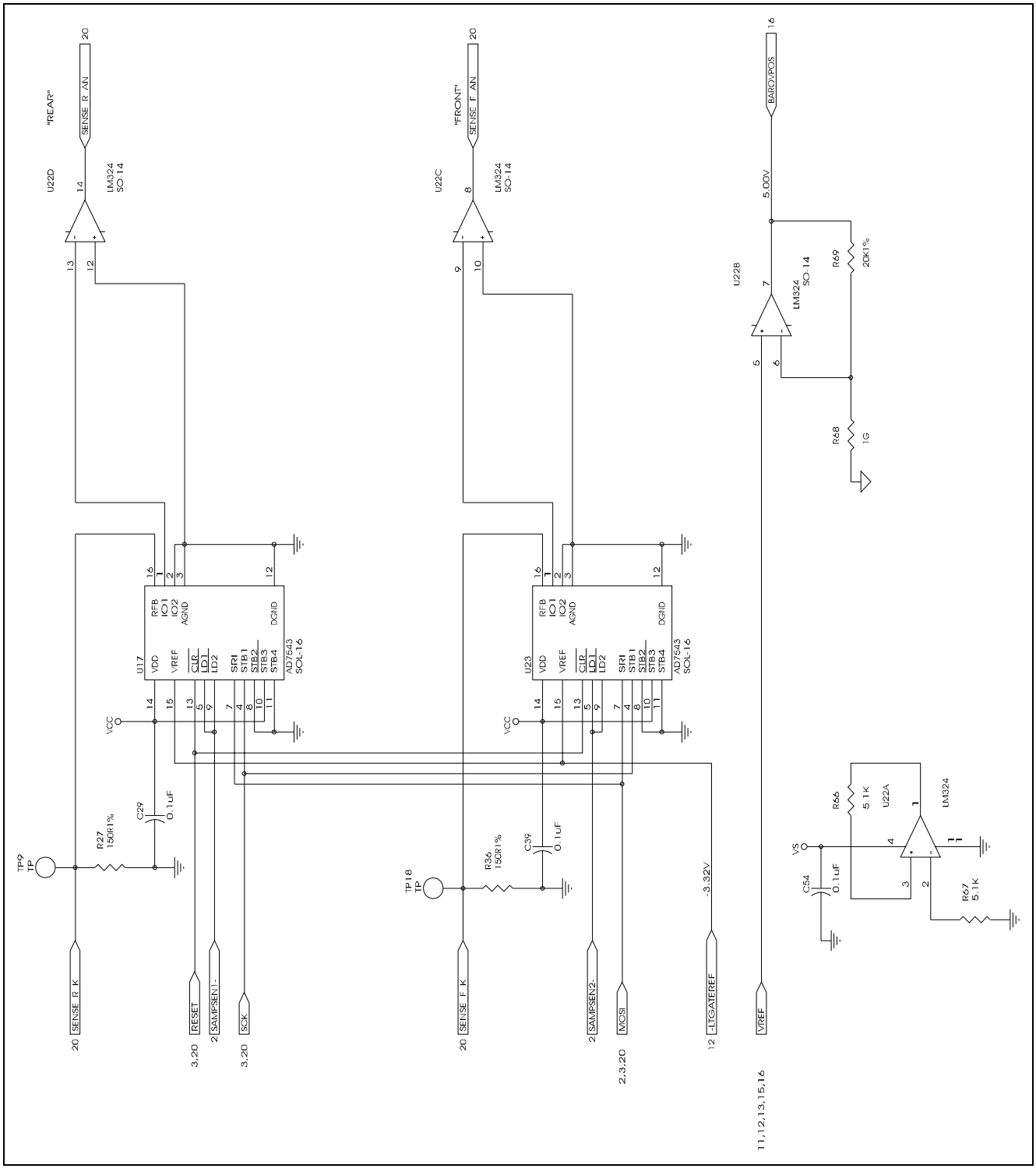


MAIN BOARD - SMC Temperature Control Circuit Sheet 12



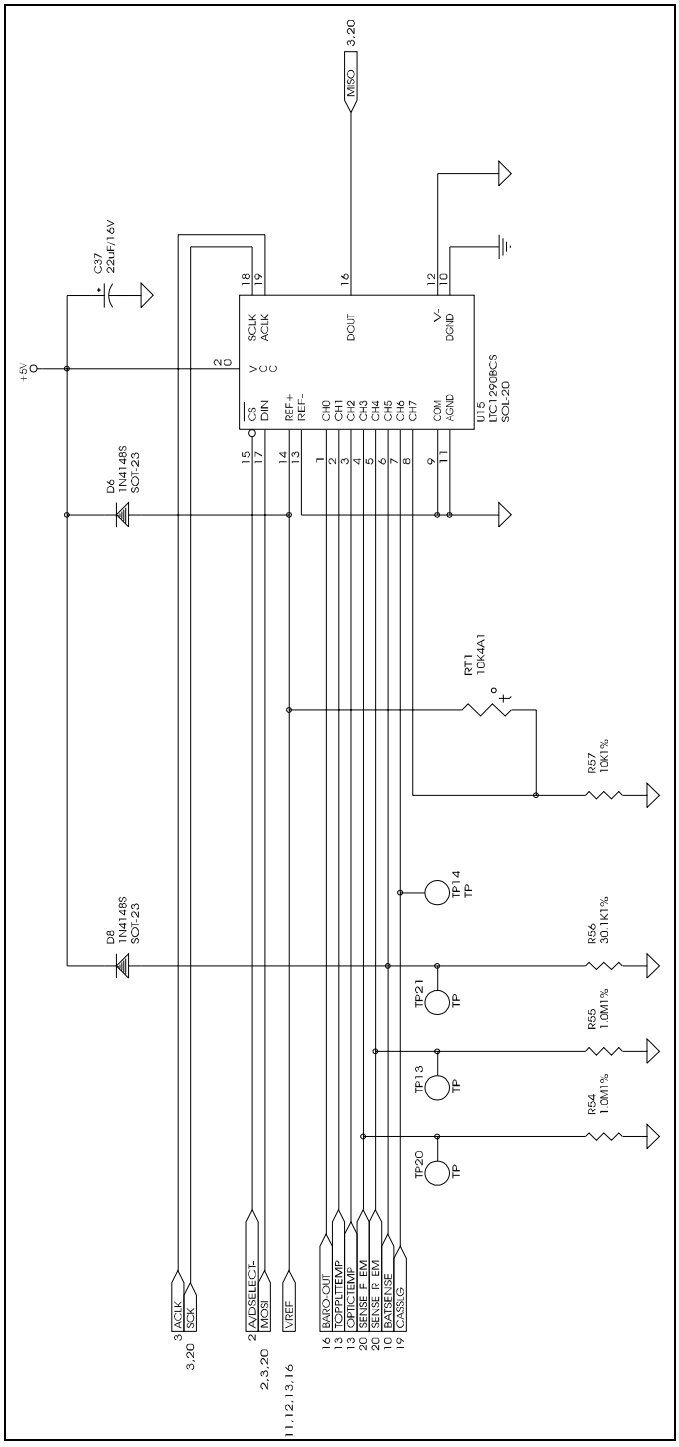

"OPTIC MODULE"
"TOP PLATE"
OTOPBASE
OBLKBASE
TOPPLTBASE
LTGATEREF
U43D
U43C
U43A
U43B
LMC6084 SO-14
C113 22uF/16V
C114 22uF/16V
C115 22uF/16V
R152 392R1%
R156 392R1%
R166 392R1%
R153 10K1%
R155 10K1%
R167 10K1%
R164 2.4_1W
R158 3.3_1W
R172 3.6_1W
R173 2.4_1W
R157 3.3_1W
R163 3.6_1W
R170 20K1%
R169 30.1K1%
R162 30.1K1%
R171 20K1%
-3.32V
+V8
-V8
R148 1C
R178 1C
D19 1N4148 SOT-23
D20 1N4148 SOT-23
D37 1N4148 SOT-23
D38 1N4148 SOT-23
R154 5.1K
R168 5.1K
OPTICCTRL
OTOPEMIT1
OTOPEMIT2
OBLKEMIT1
OBLKEMIT2
TOPPLTCTRL
TOPPLTEMIT1
TOPPLTEMIT2
VREF
11,13,15,16
+5V
-5V
R160 10
C100 0.1uF
C101 0.1uF
R161 10


OPTICTEMP
TOPPLTTEMP
BCHRG2
R64
332R1%
R128
332R1%
C81
0.1uF
C82
0.1uF
R124
90.9K1%
R125
90.9K1%
U33A
U33C
LMC6084
SO-14
-V9
+V9
R123
30.1K1%
R126
30.1K1%
R136
5KPOT
OPTIC TEMP IND
CW TO LOWER
R100
5KPOT
TOP TEMP IND
CW TO LOWER
R139
20K1%
R98
20K1%
R215
10M
D28
1N4148S
SOT-23
R216
332R1%
U33B
R150
10M
R122
4.02K1%
R127
4.02K1%
R137
49.9K1%
R101
49.9K1%
R138
100K1%
R102
100K1%
R213
10K1%
R214
1.21K1%
R149
20K1%
R140
10
C88
0.1uF
C75
0.1uF
R99
10
+5V
-5V
OPTICNTC1
TOPPLTNTC1
VREF
11,20
11,20
11,12,15,16


"REAR"
SENSE R AN
U22D
LM324 SO-14
"FRONT"
SENSE F AN
U22C
LM324 SO-14
BARO/POS
5.00V
U22B
LM324 SO-14
R69 20K1%
R68 1G
U17
U23
AD7543 SOL-16
VCC
VDD
VREF
RFB
IO1
IO2
AGND
DGND
CLR
LD1
LD2
SRI
STB1
STB2
STB3
STB4
R27 150R1%
C29 0.1uF
R36 150R1%
C39 0.1uF
TP9 TP
TP18 TP
-3.32V
SENSE R K
RESET
SAMPSEN1-
SCK
SENSE F K
SAMPSEN2-
MOSI
-LTGATEREF
VREF
11,12,13,15,16
R66 5.1K
U22A
LM324
C54 0.1uF
R67 5.1K
VS

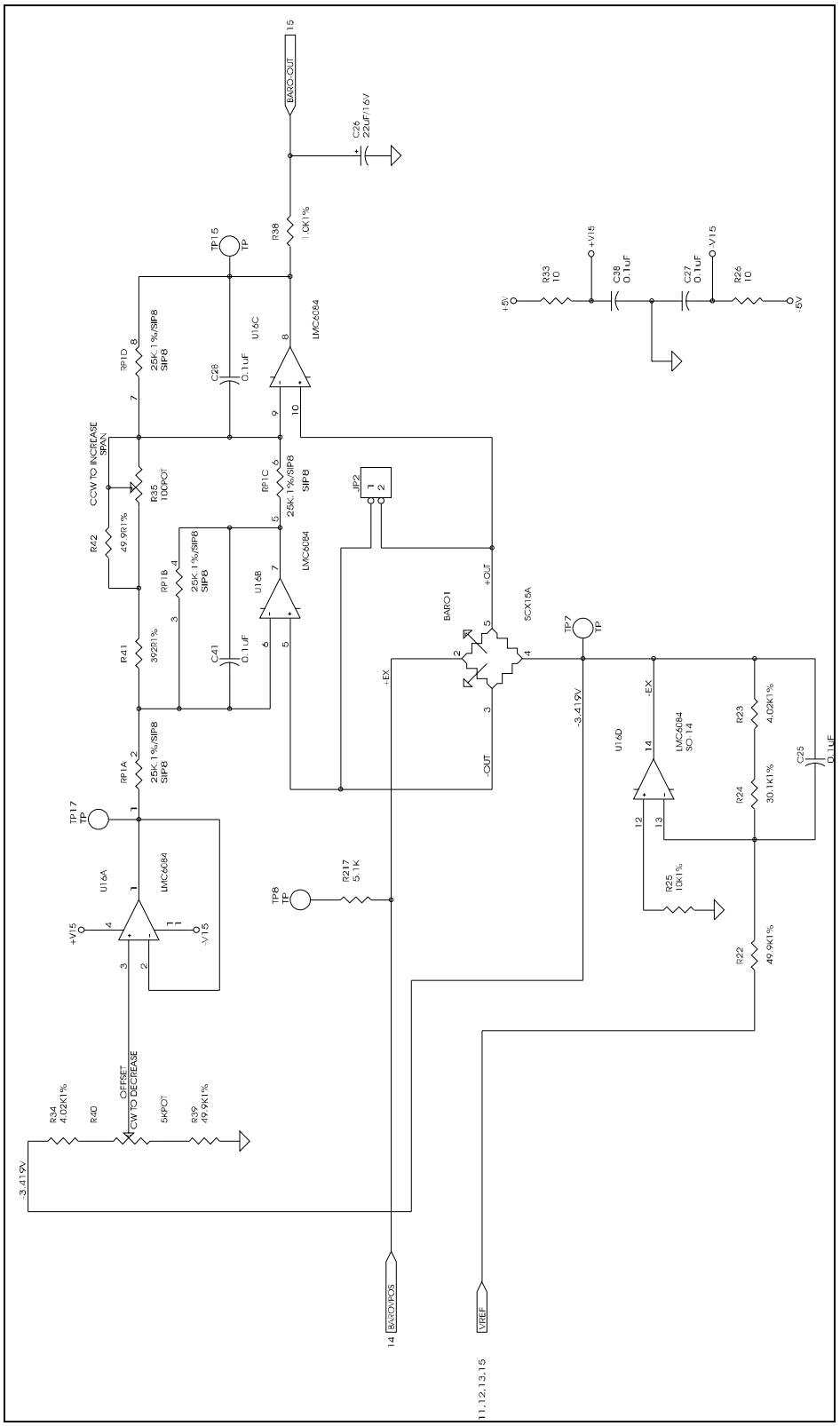
MAIN BOARD - A/D Converter Circuit

Sheet 16



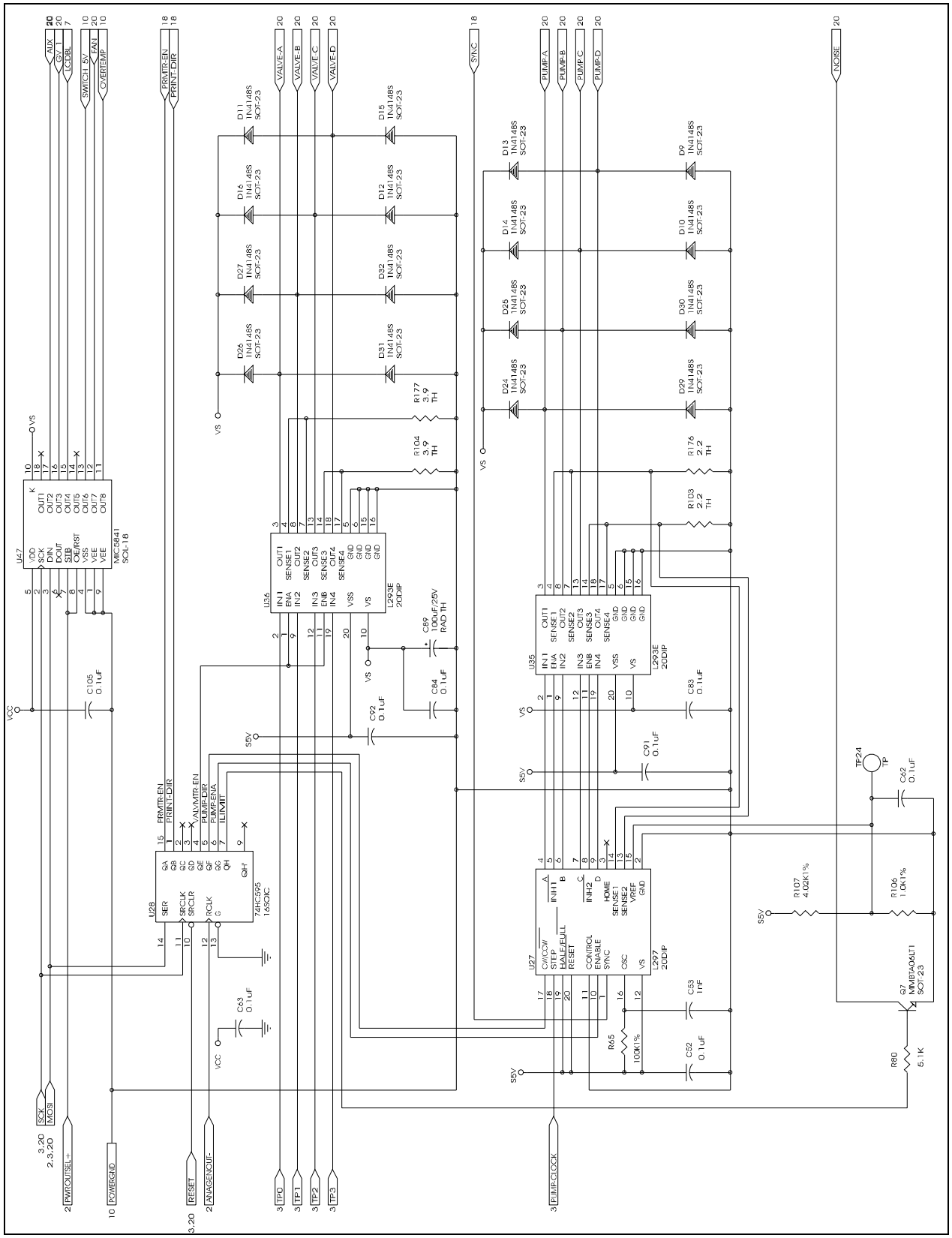
MAIN BOARD - Barometer Circuit

Sheet 17



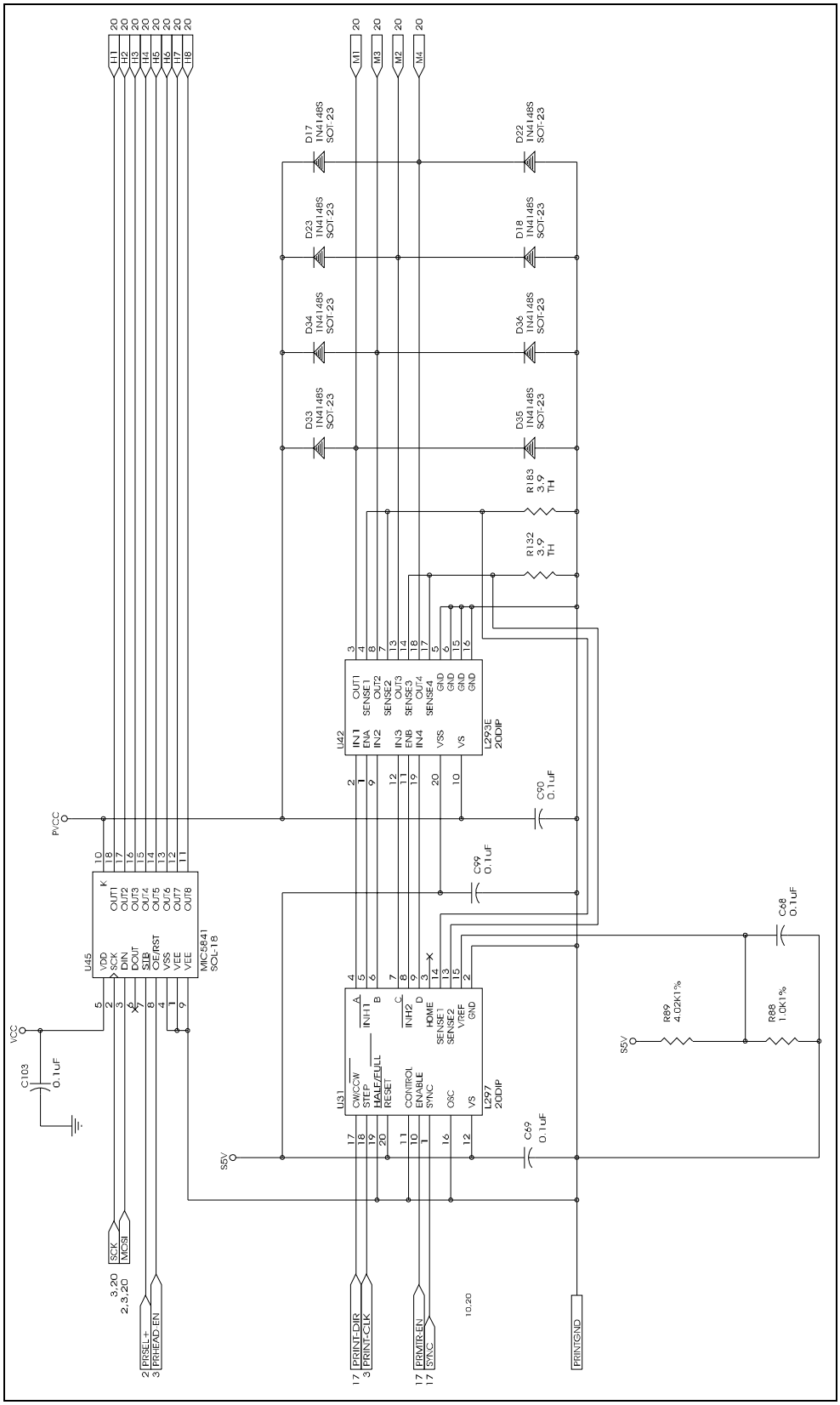
MAIN BOARD - Motor Drive Control Circuit

Sheet 18

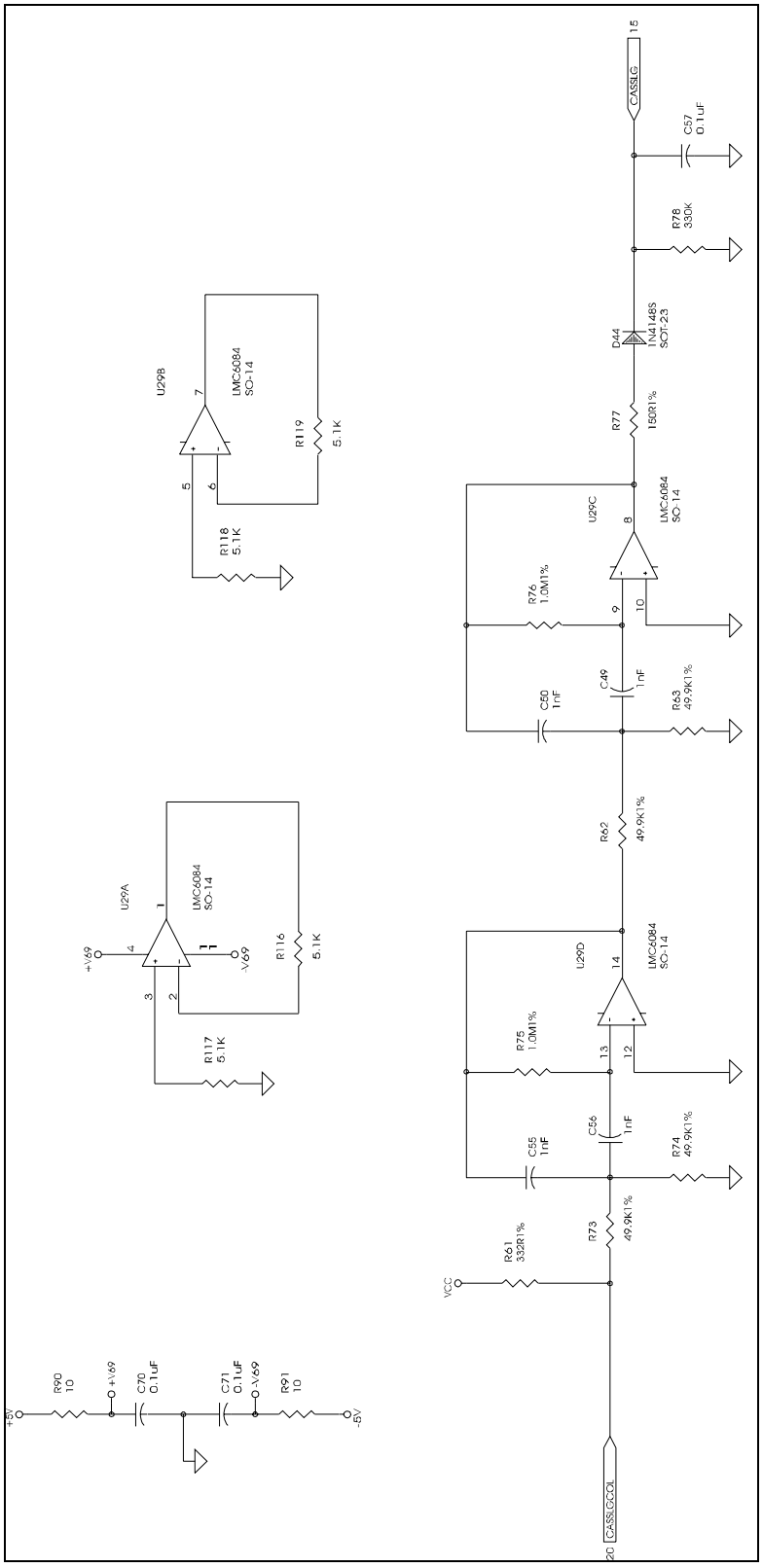


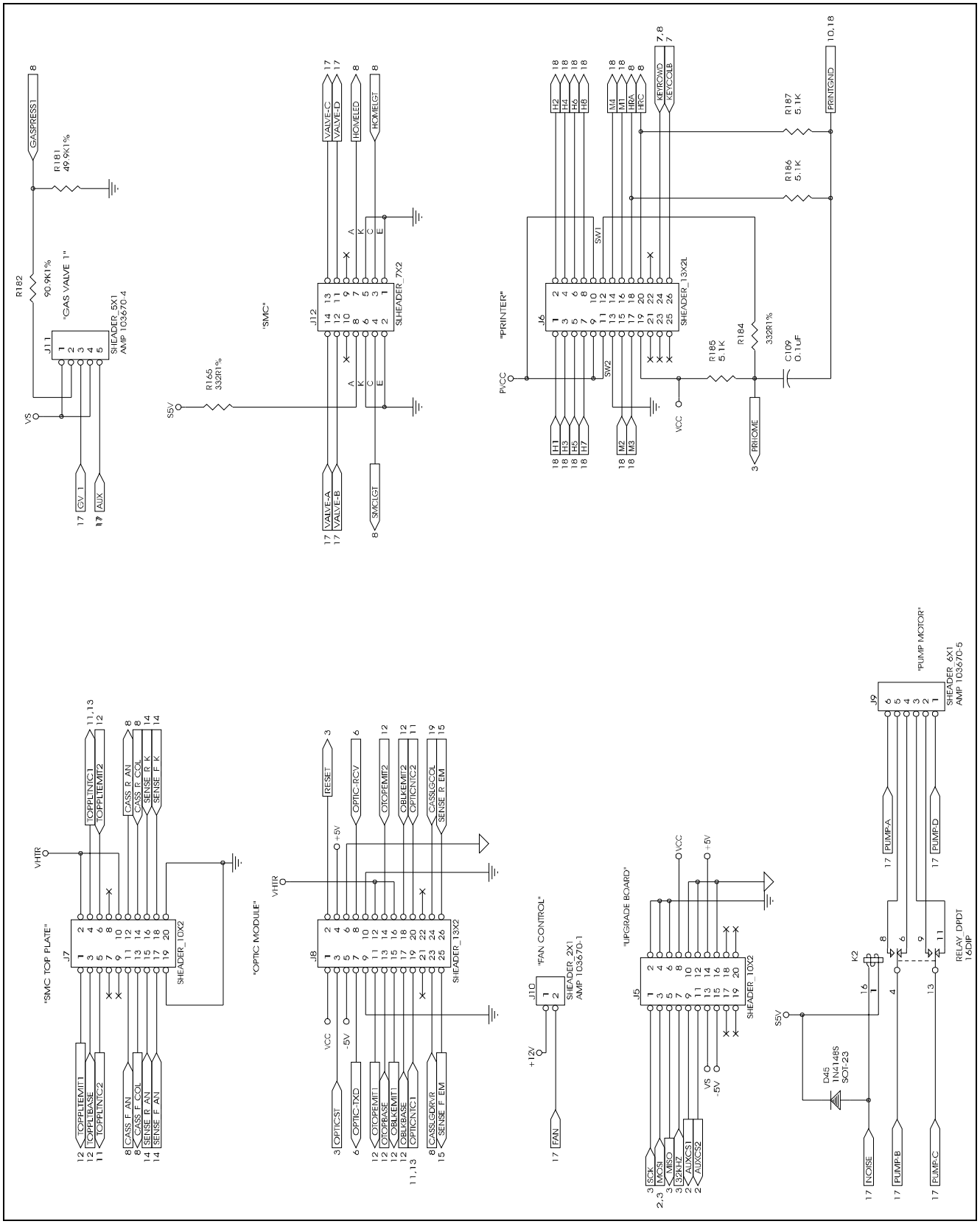
MAIN BOARD - Printer Controller Circuit

Sheet 19



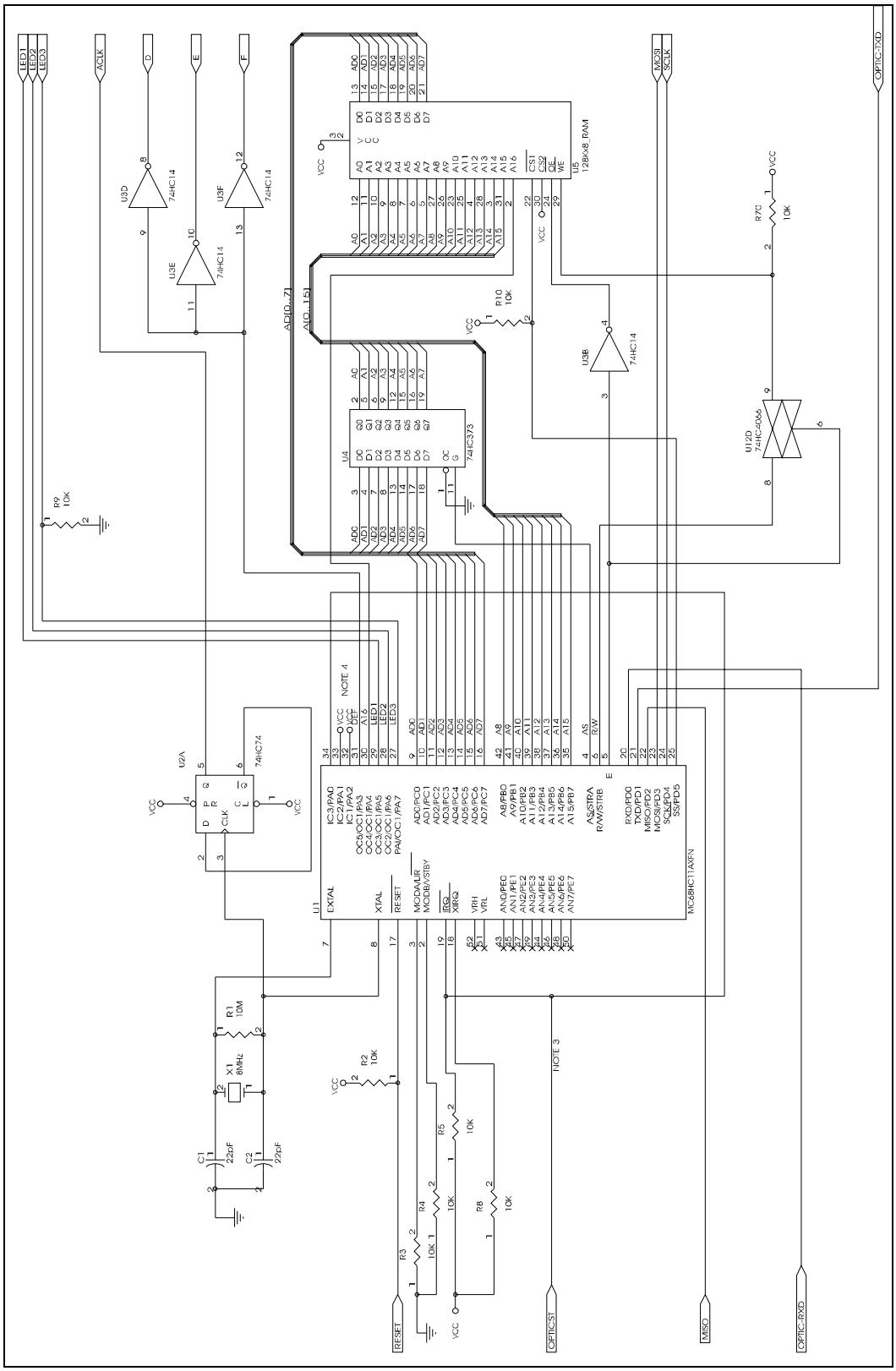
MAIN BOARD - Cassette Detection Circuit Sheet 20



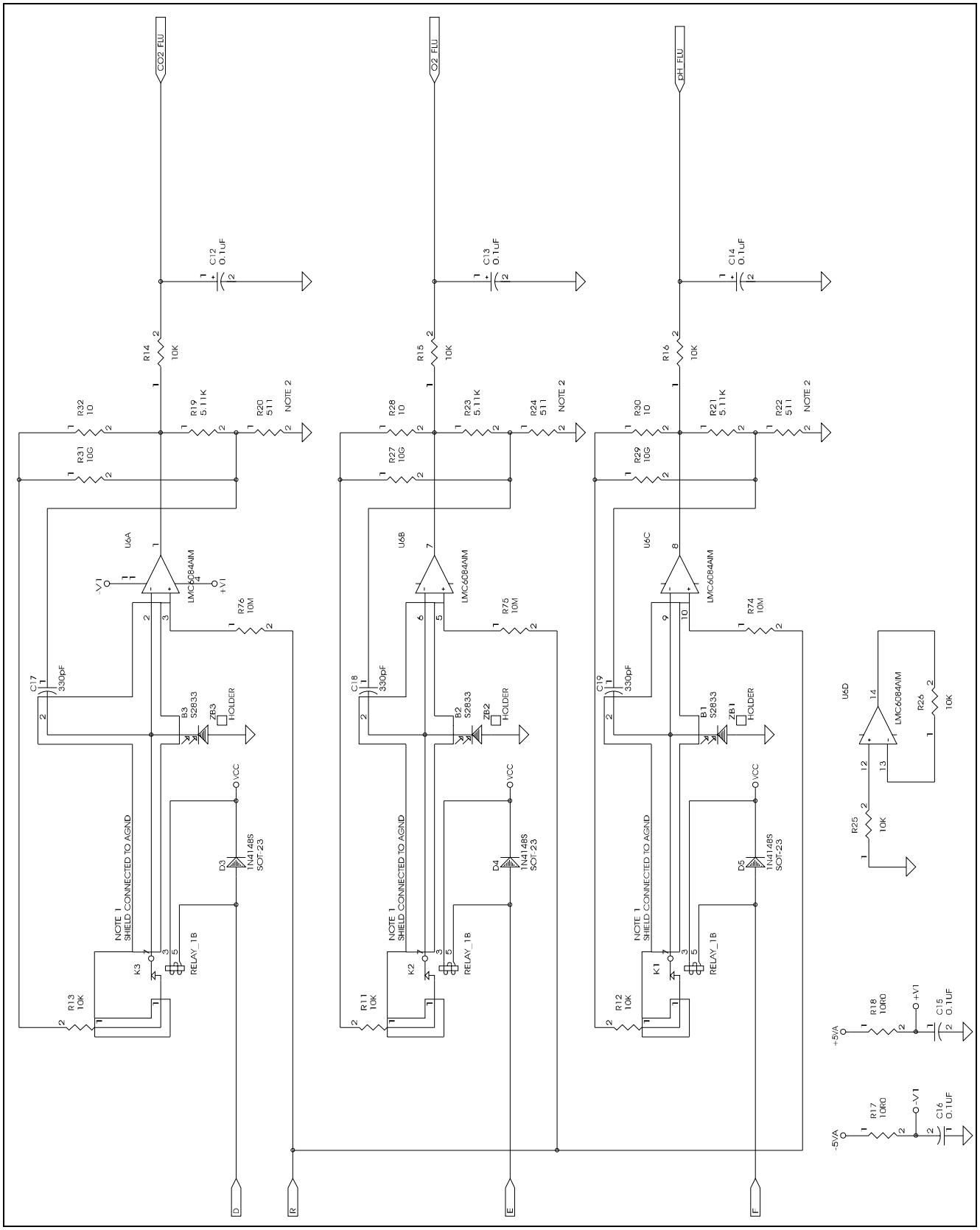

"GAS VALVE 1"
"SMC"
"PRINTER"
"SMC TOP PLATE"
"OPTIC MODULE"
"FAN CONTROL"
"UPGRADE BOARD"
"PUMP MOTOR"
R182 90.9K1%
R181 49.9K1%
R165 332R1%
R184 332R1%
R185 5.1K
R186 5.1K
R187 5.1K
C109 0.1UF
D45 1N4148S SOT-23
K2 RELAY_DPDT 1.6DIP
J11 SHEADER_5X1 AMP 103670-4
J12 SLHEADER_7X2
J6 SHEADER_13X2L
J7 SHEADER_10X2
J8 SHEADER_13X2
J10 SHEADER_2X1 AMP 103670-1
J5 SHEADER_10X2
J9 SHEADER_6X1 AMP 103670-5
GASPRESS1
GV 1
AUX
VALVE-A
VALVE-B
VALVE-C
VALVE-D
HOMELED
HOMELGT
SMCLGT
PRIOME
PRINTGND
KEYROWD
KEYCOLB
PVCC
VCC
VHTR
+5V
-5V
+12V
VS
S5V
TOPPLTNTC1
TOPPLTEMIT2
TOPPLTEMIT1
TOPPLTBASE
TOPPLTNTC2
CASS R AN
CASS R COL
SENSE R K
SENSE F K
CASS F AN
CASS F COL
SENSE R AN
SENSE F AN
RESET
OPTIC-RCV
OPTOPEMIT2
OBLKEMIT2
OPTICNTC2
CASSLGCOL
SENSE R EM
OPTIC-TXD
OPTOPEMIT1
OPTOPLIGHT
OBLKBASE
OPTICNTC1
CASSLGDRVR
SENSE F EM
OPTIC-ST
FAN
SCK
MOSI
MISO
32KHZ
AUXCS1
AUXCS2
PUMP-A
PUMP-B
PUMP-C
PUMP-D
NOISE

OPTIC MODULE - Microprocessor Circuit

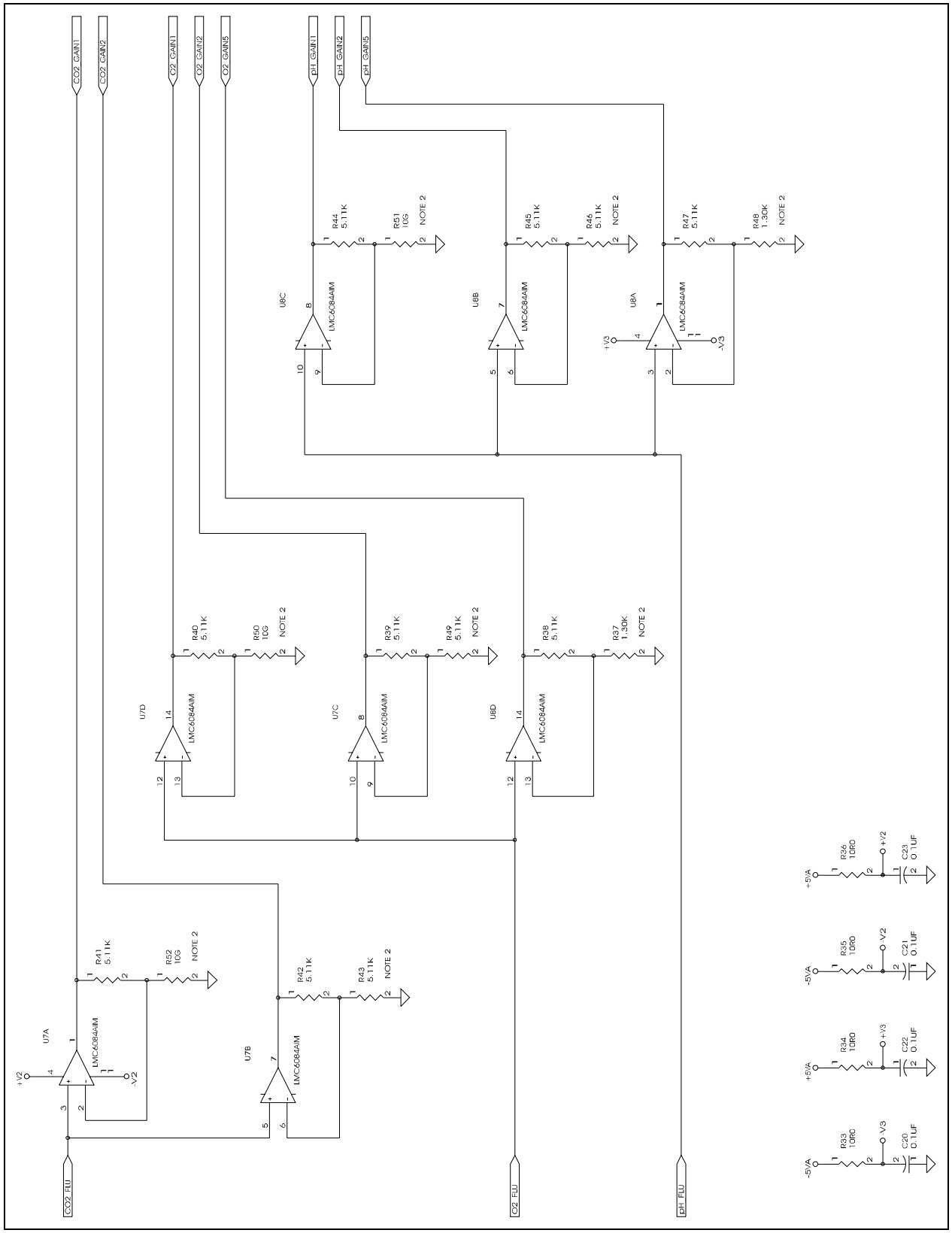
Sheet 1



OPTIC MODULE - Photo Detection Circuit Sheet 2

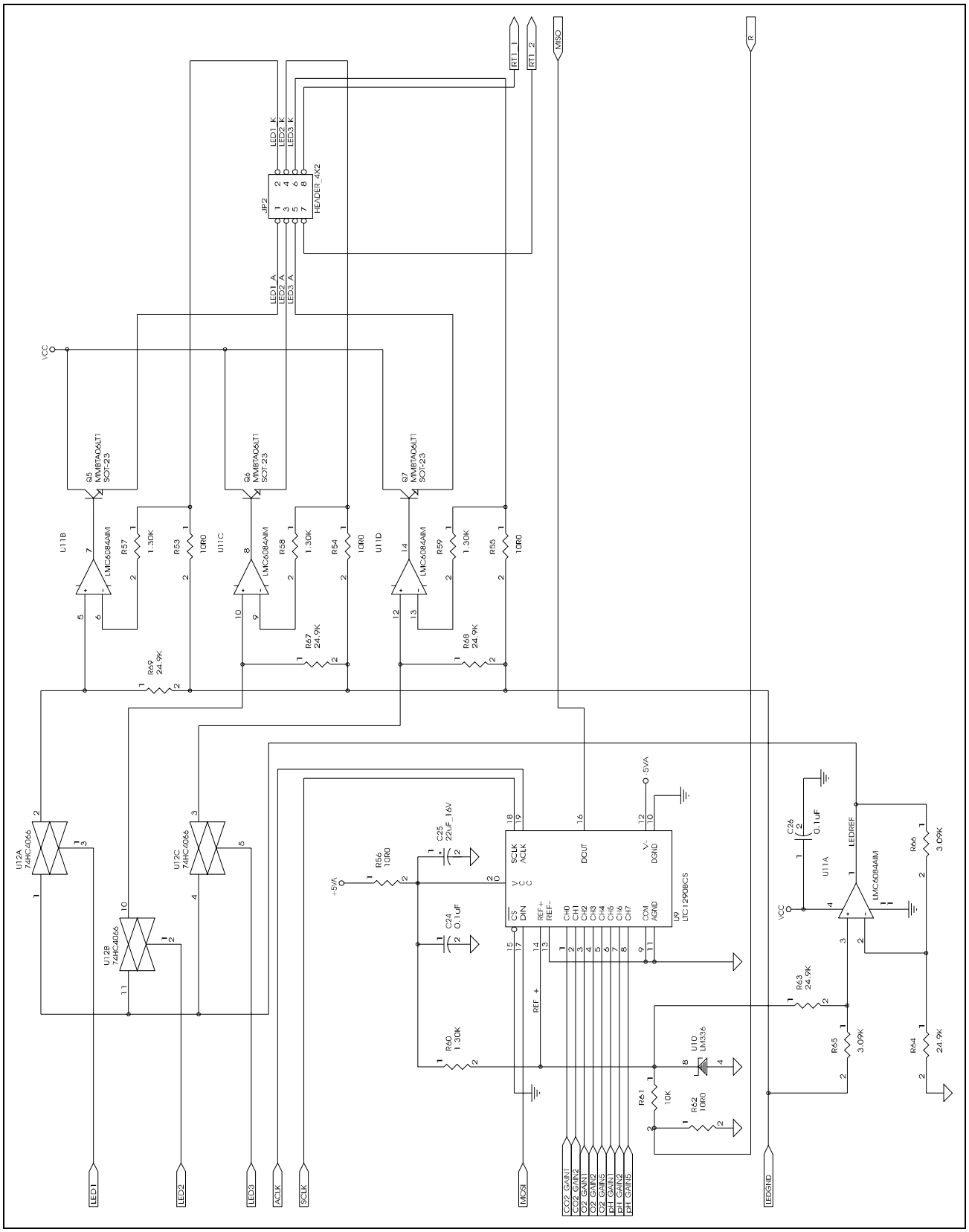


OPTIC MODULE - Photo Detector Gain Circuit Sheet 3

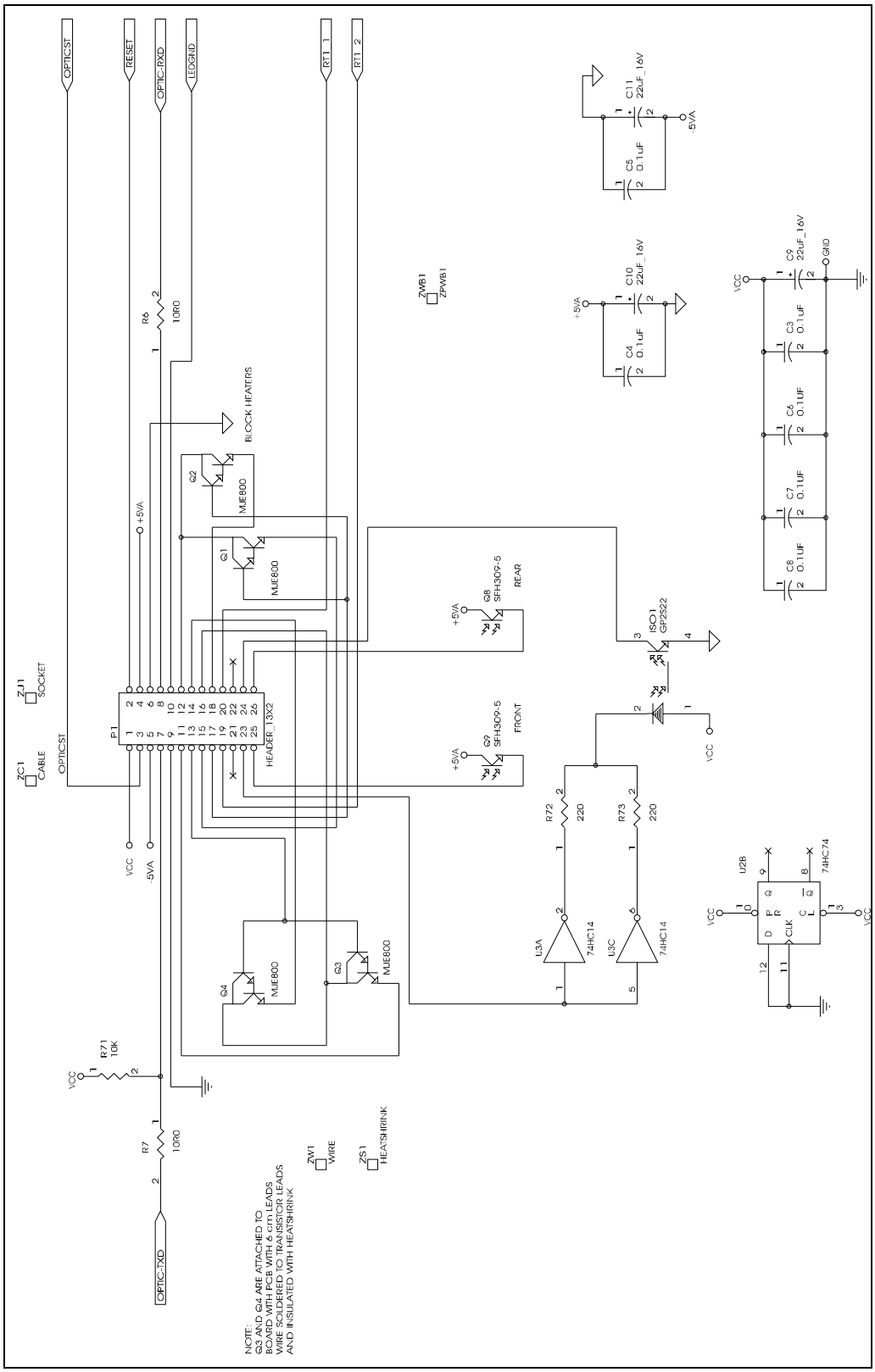


OPTIC MODULE - A/D Converter Circuit

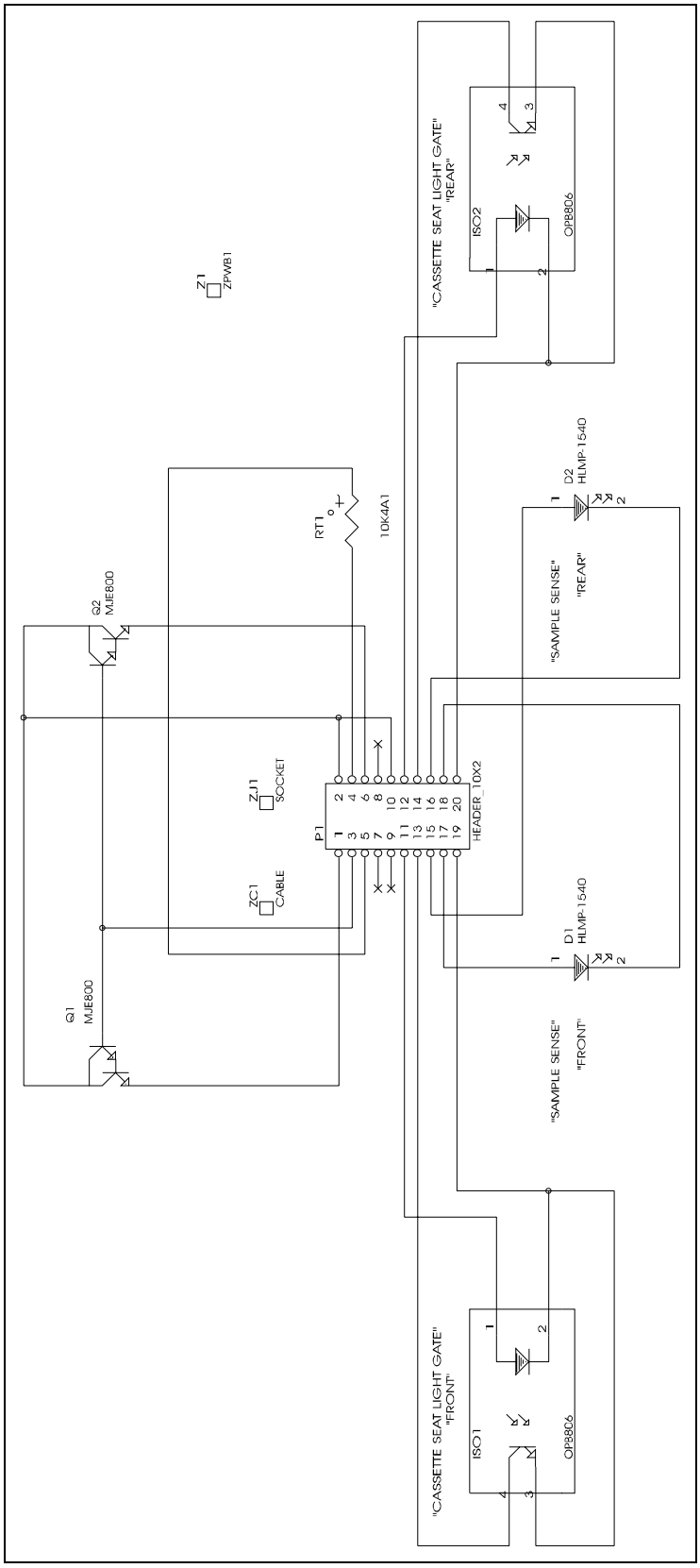
Sheet 4



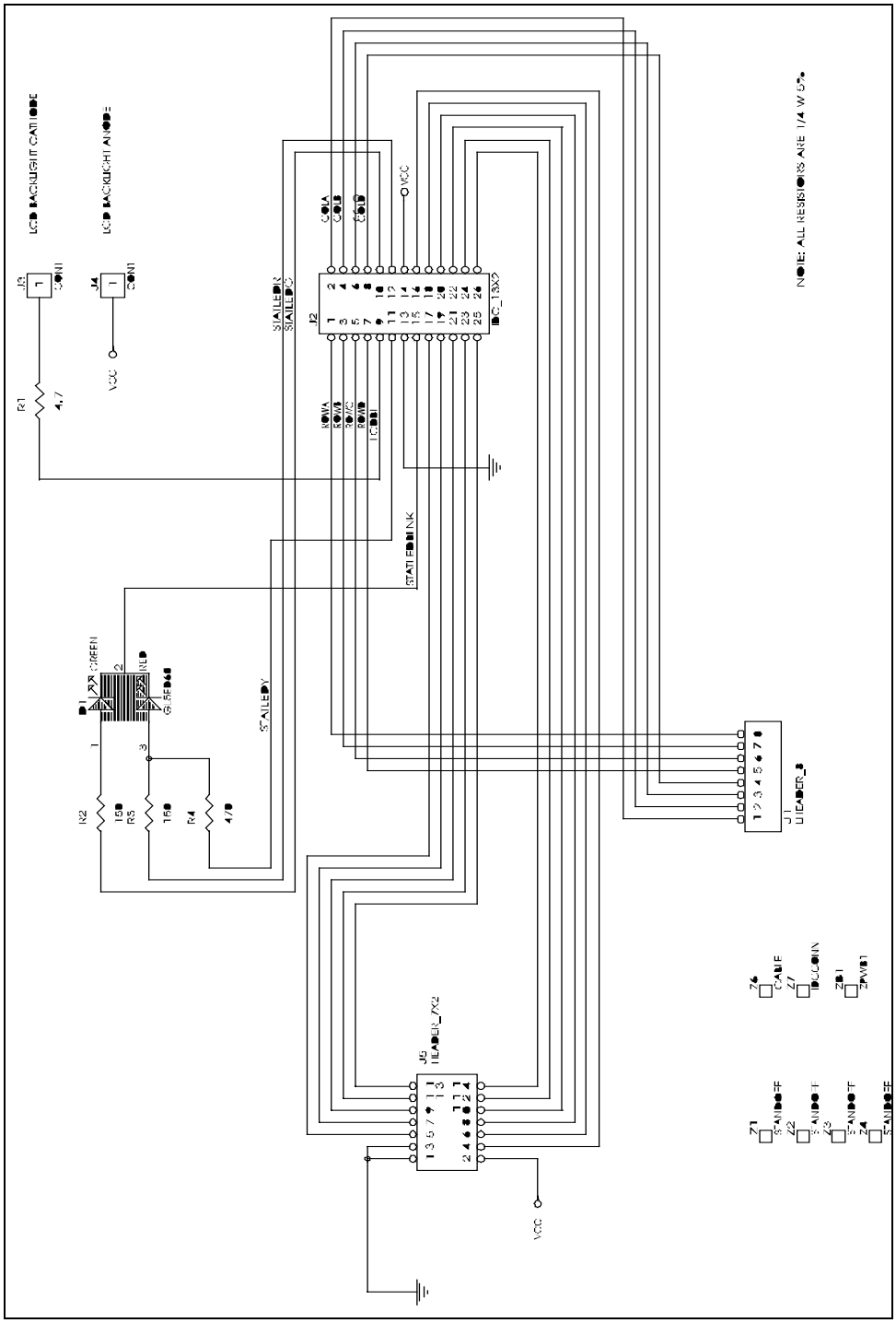
OPTIC MODULE - Cassette Detection Circuit Sheet 5



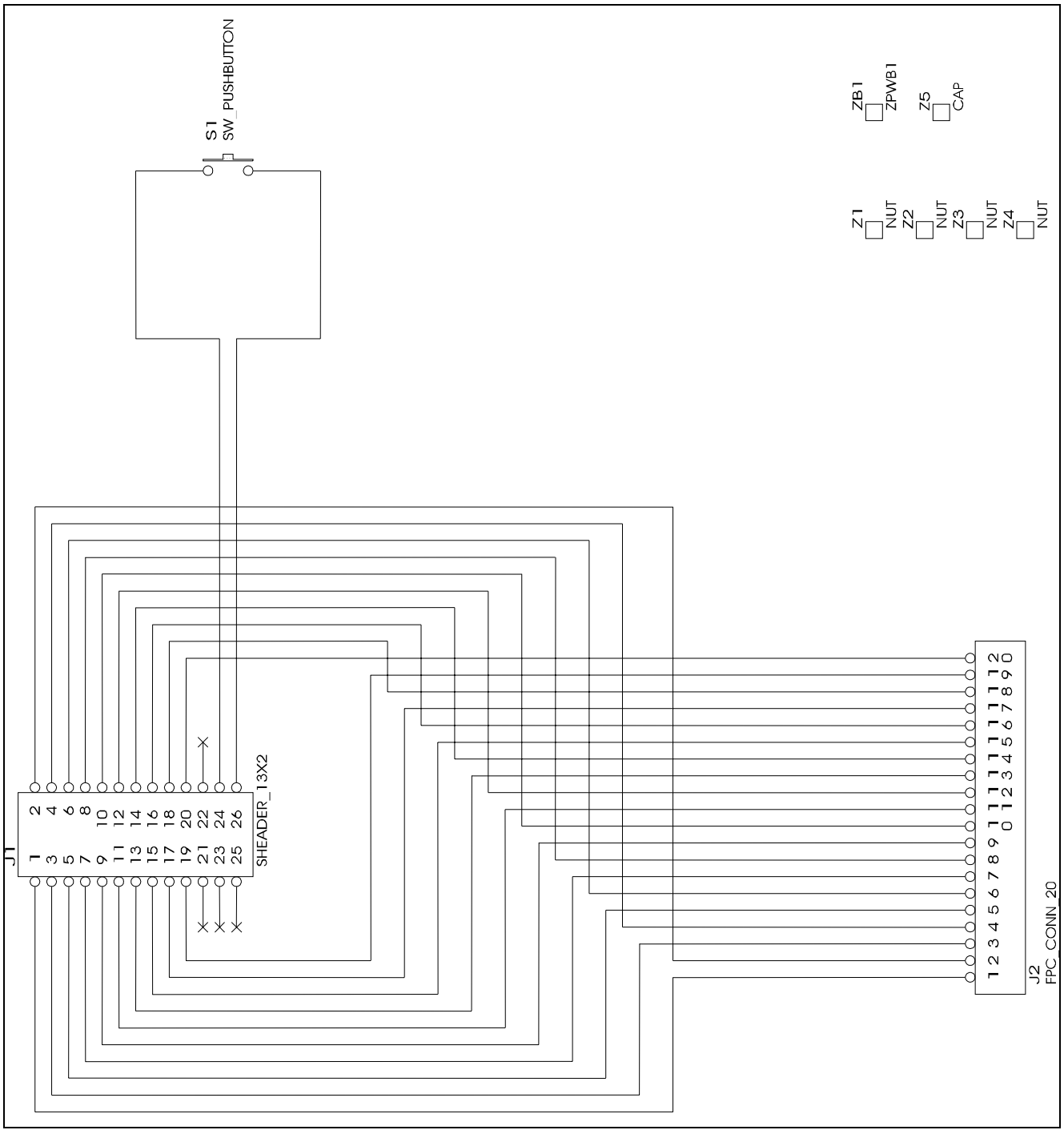
HEATER BOARD - SMC Top Plate



DISPLAY BOARD - Interconnect



PRINTER BOARD - Interconnect Diagram



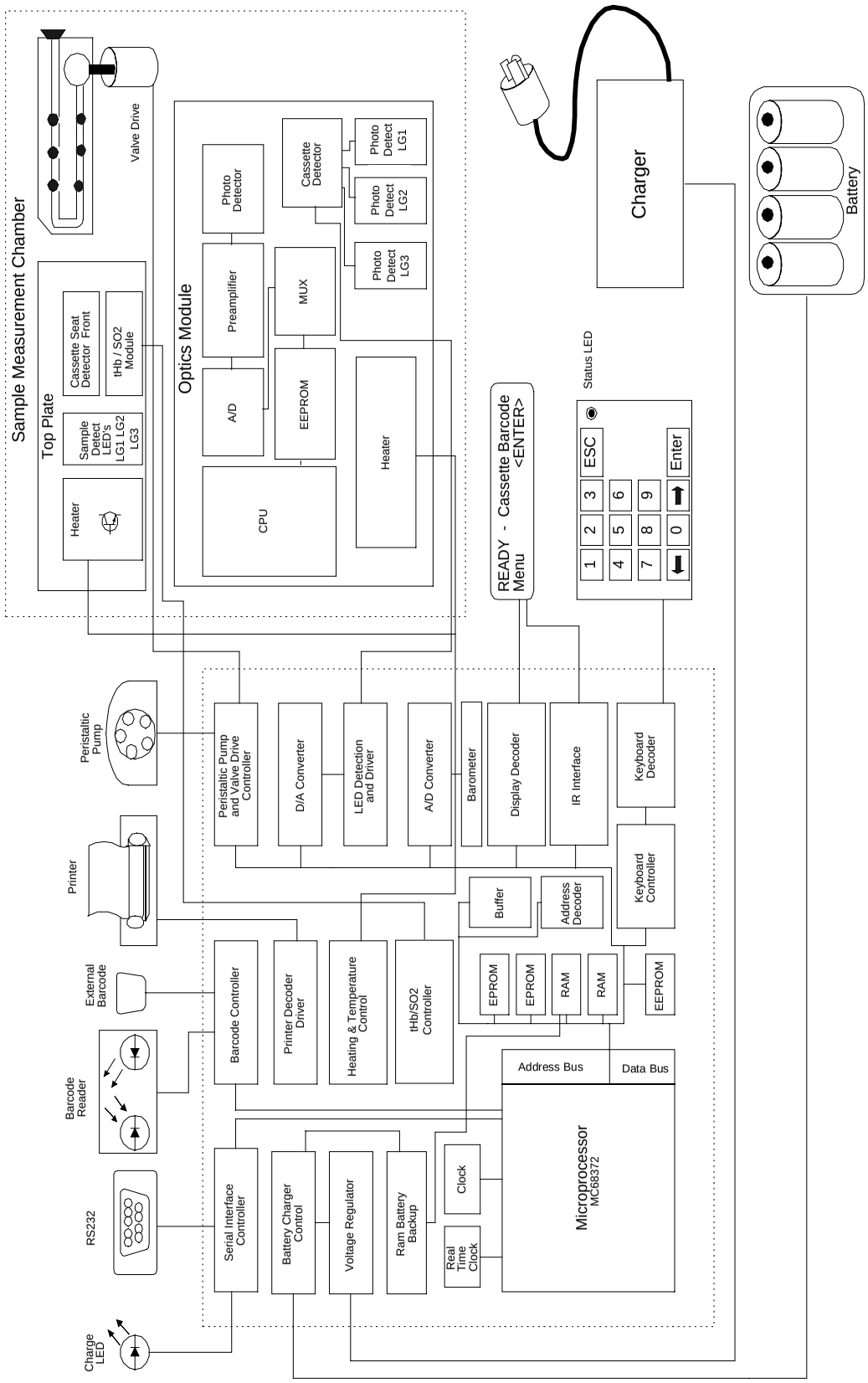
OPTI CCA System

The system electronic diagrams are included to provide service personnel a reference for tracing system signals when troubleshooting the OPTI CCA system. The electronic diagrams have been divided into sections to accommodate standard paper sizes. Each diagram provides signal labels which indicate input and output signals for that section of the circuitry. In addition to the signal labels, numbers are provided at each signal label indicating the appropriate diagram sheet number where that signal is connected. This is done to easily locate signal interconnection throughout each section of the electronic diagram.

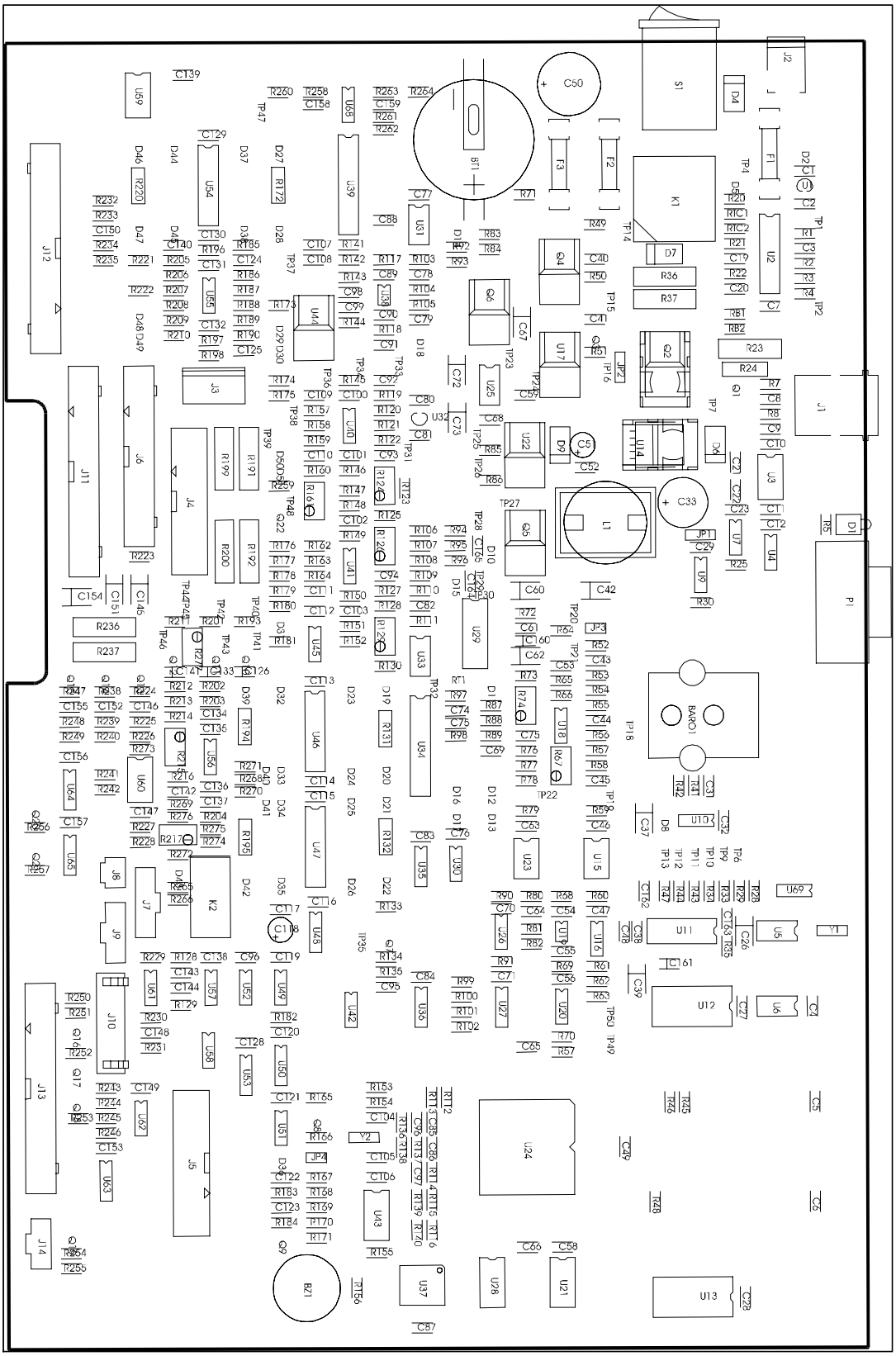
For the OPTI Main Board, there are 21 electronic diagram sections included within the service manual. Sheet one contains a system block diagram. This sheet is included to provide service personnel a reference for the overall system main signals and assembly interconnections.

OPTI CCA - System Block Diagram

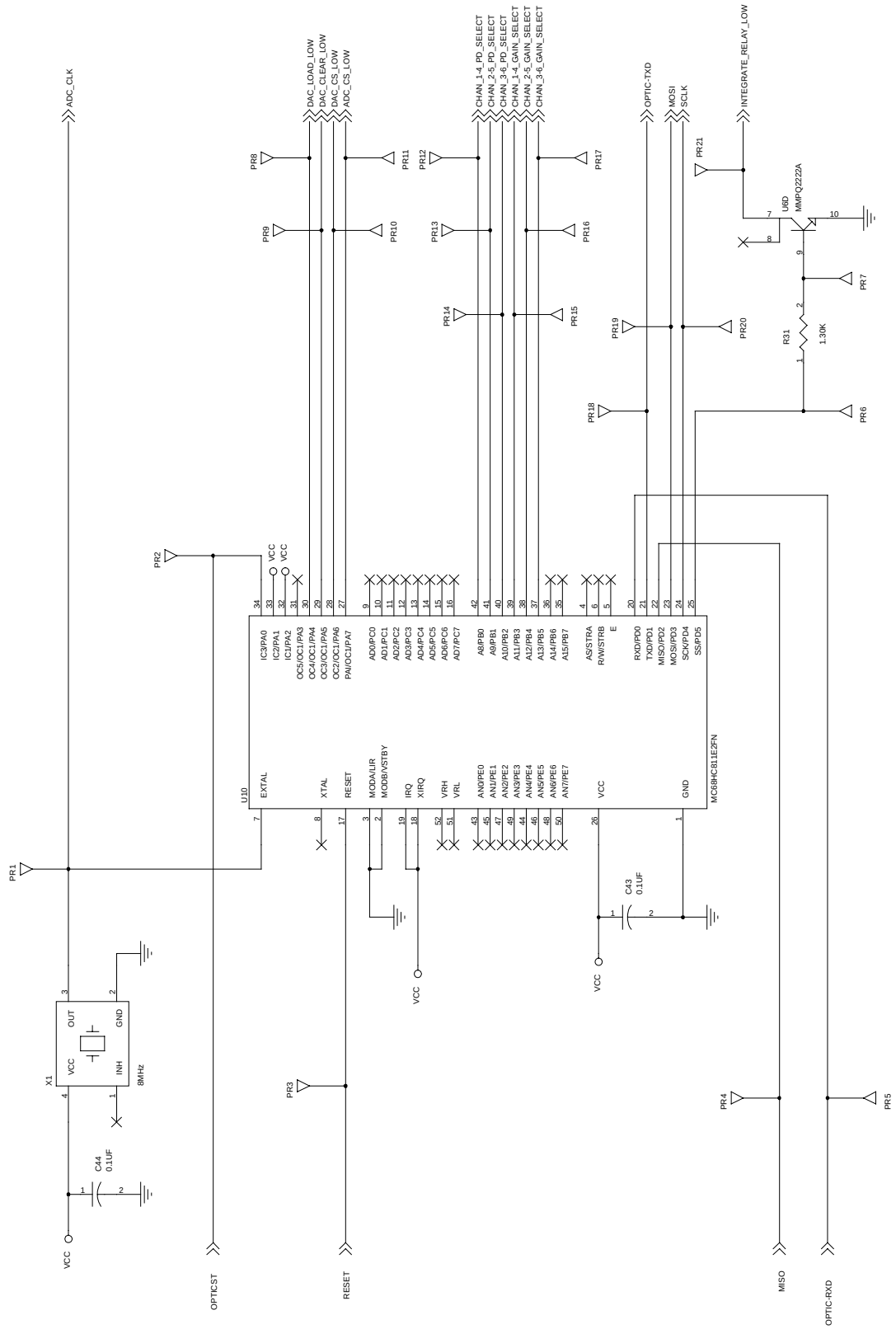
Sheet 1



MAIN BOARD - Layout

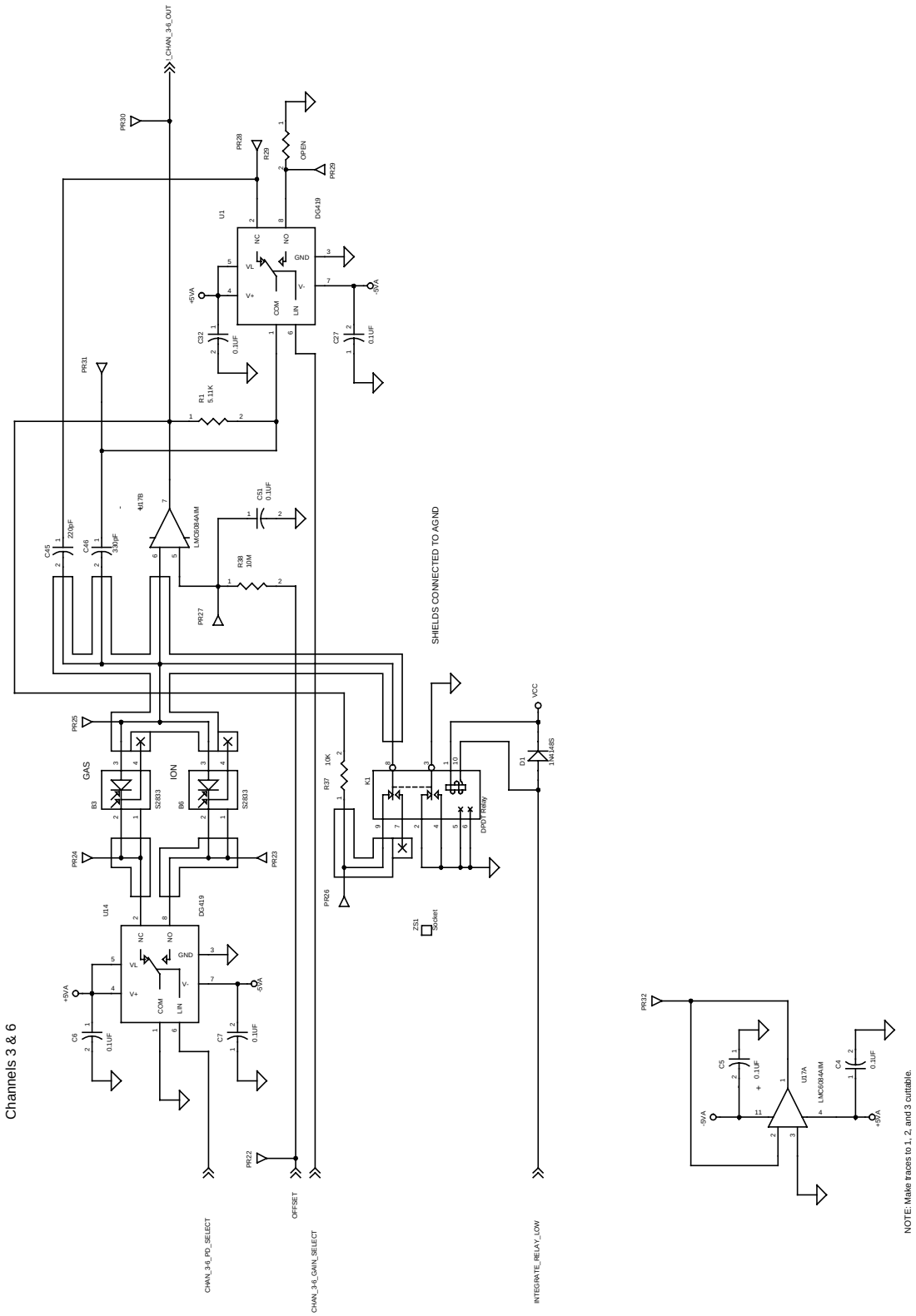


OPTICS MODULE - Digital Circuit Sheet 1

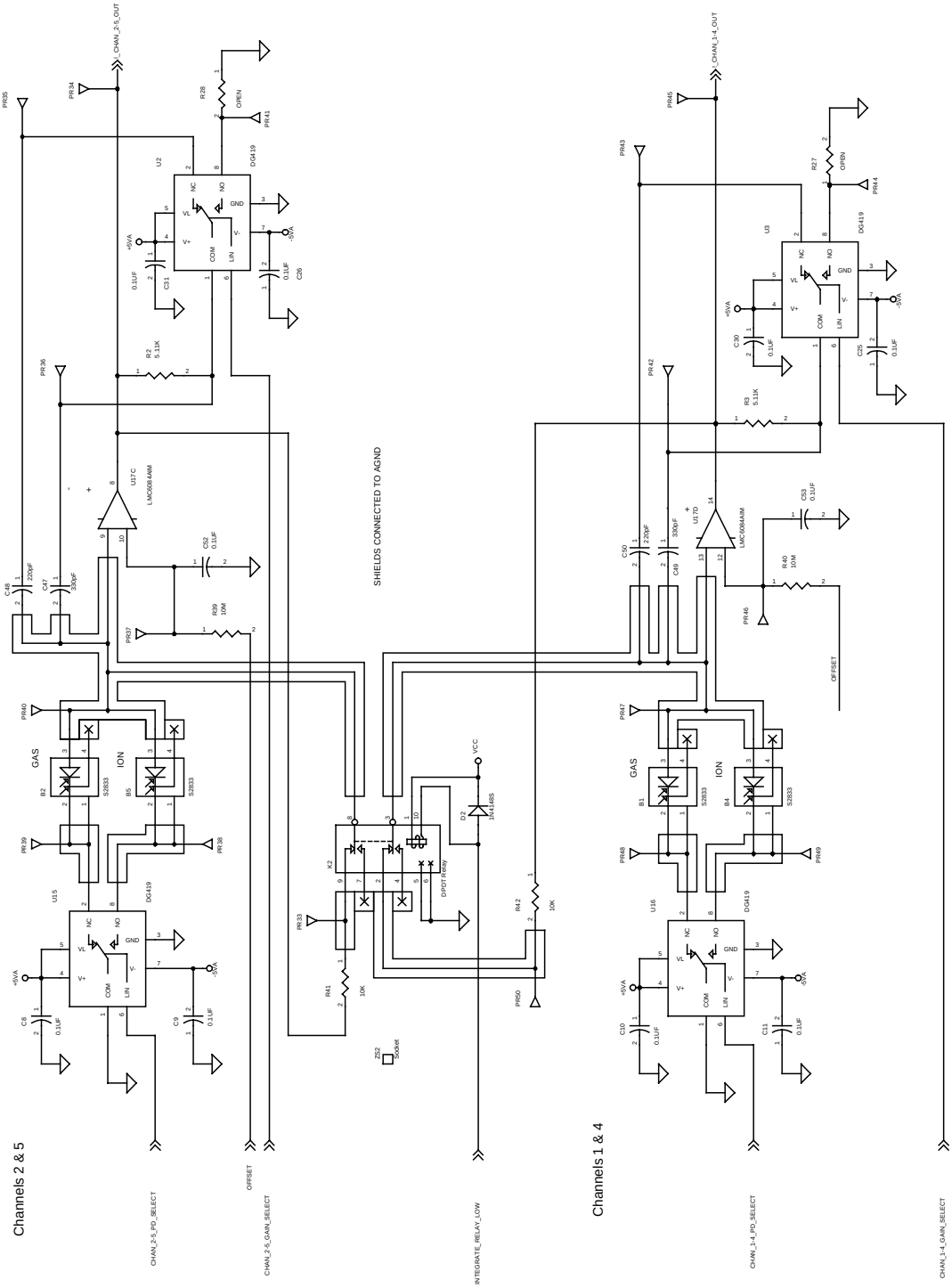


OPTICS MODULE - Amplifier Circuit

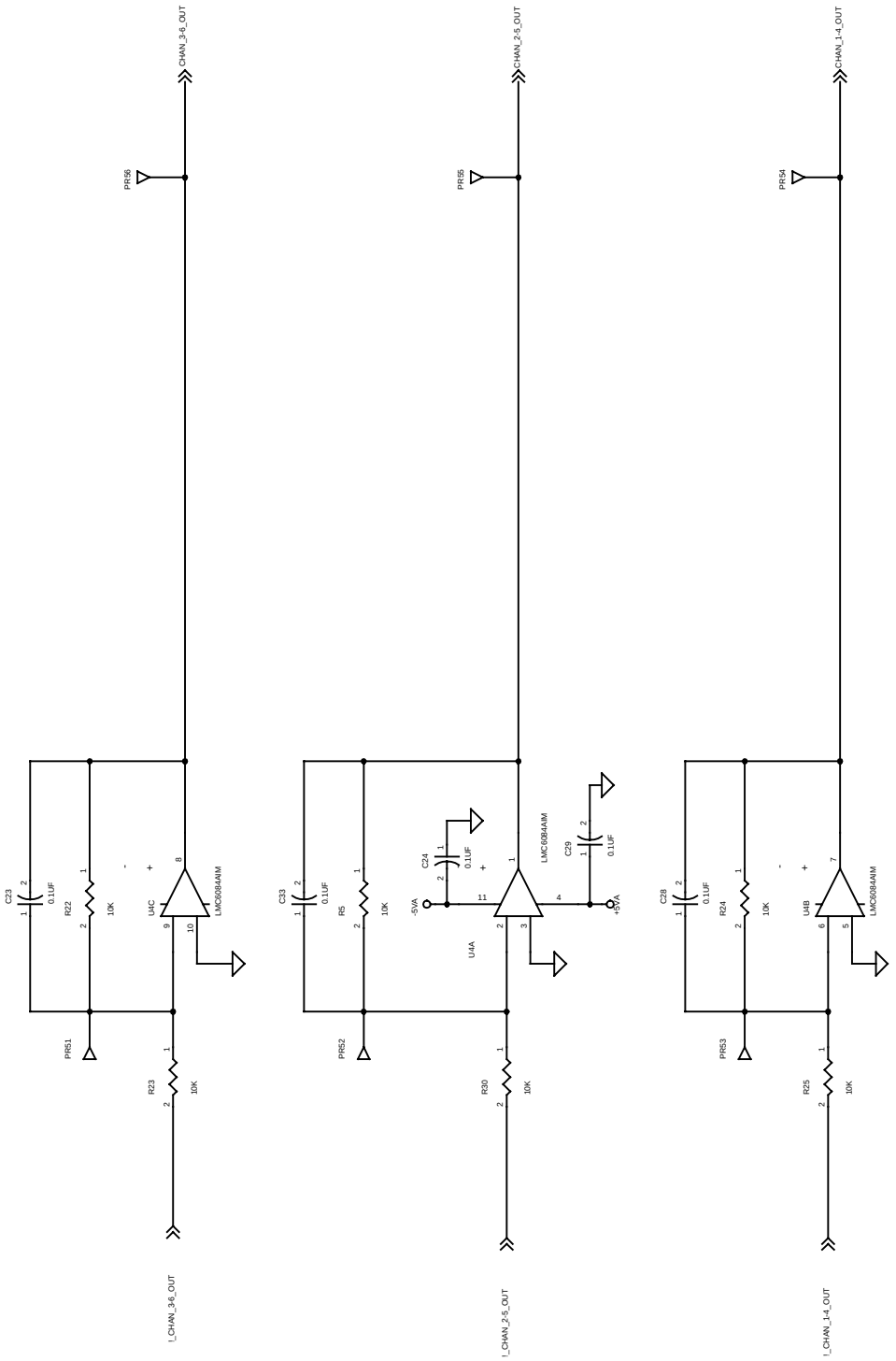
Sheet 2



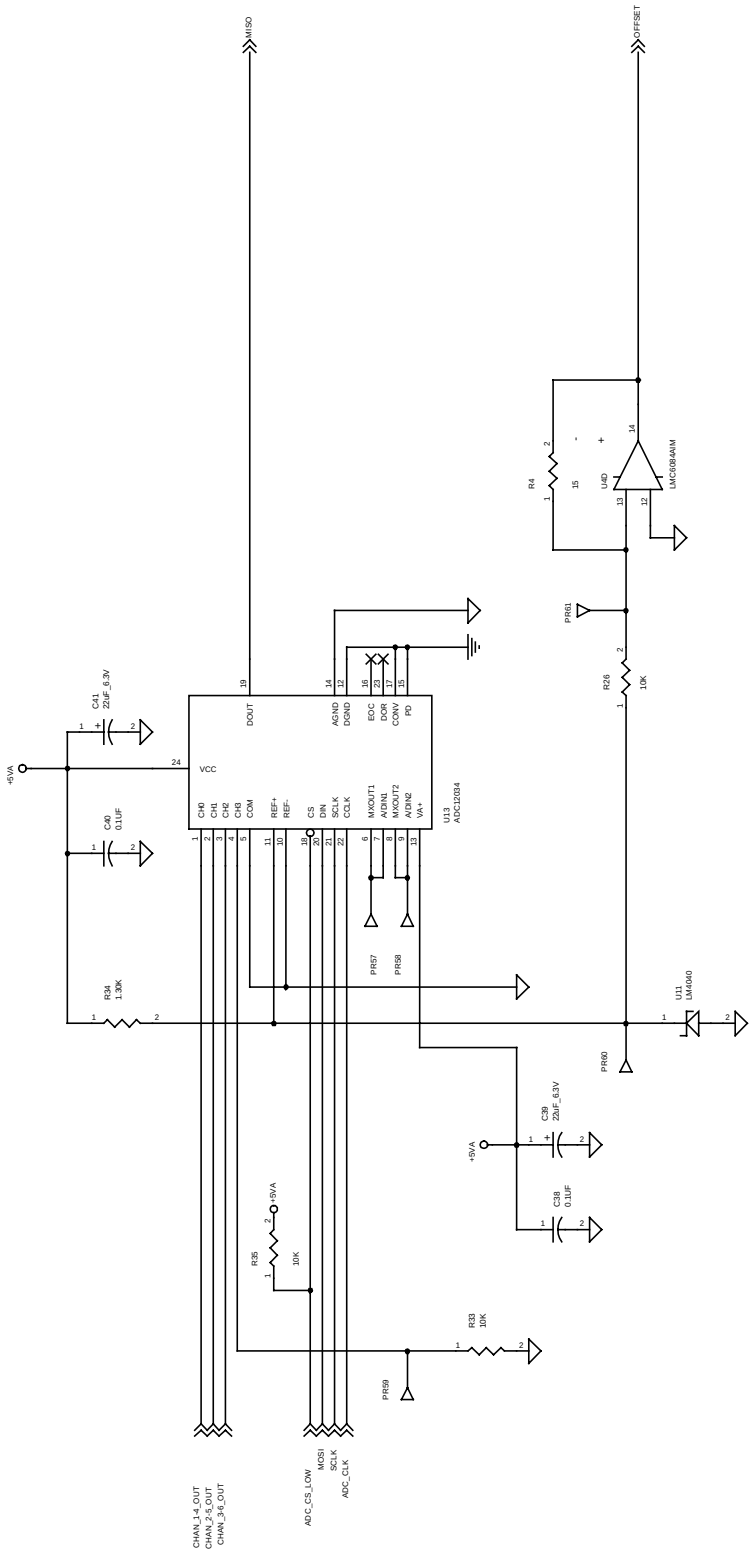
OPTICS MODULE - Amplifier Circuit Sheet 3



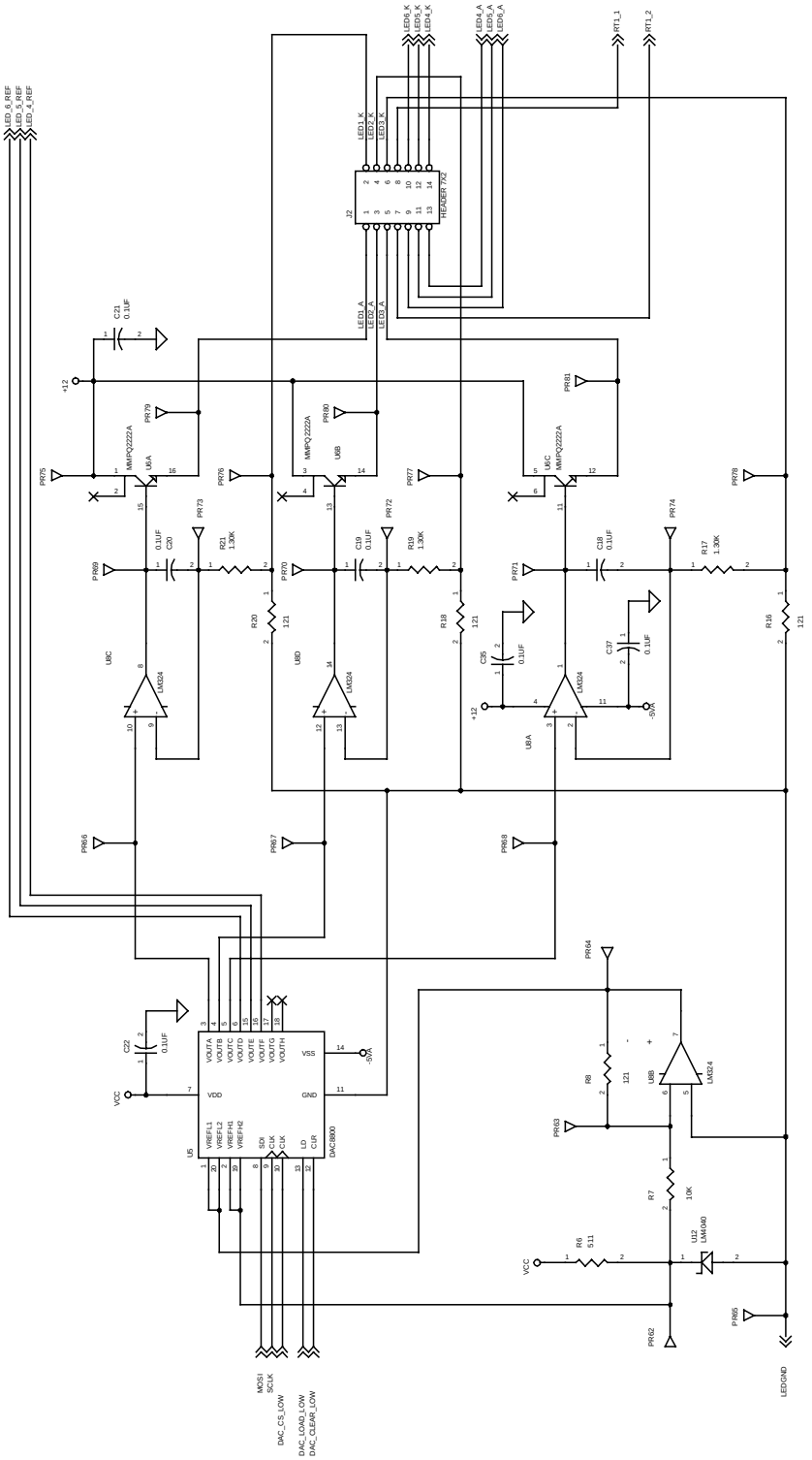
OPTICS MODULE - Inverter Circuit Sheet 4



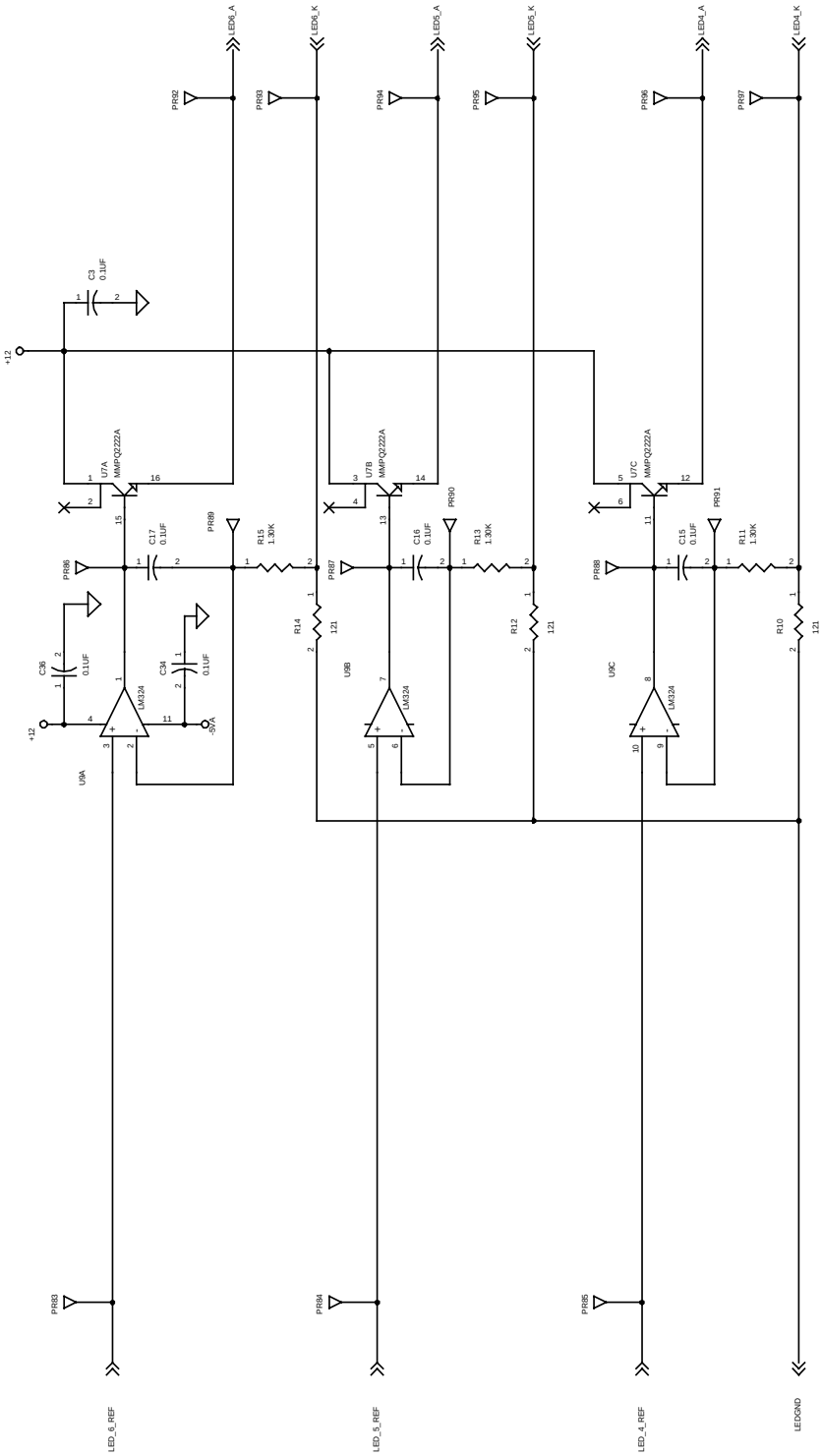
OPTICS MODULE - A-D Converter Circuit Sheet 5



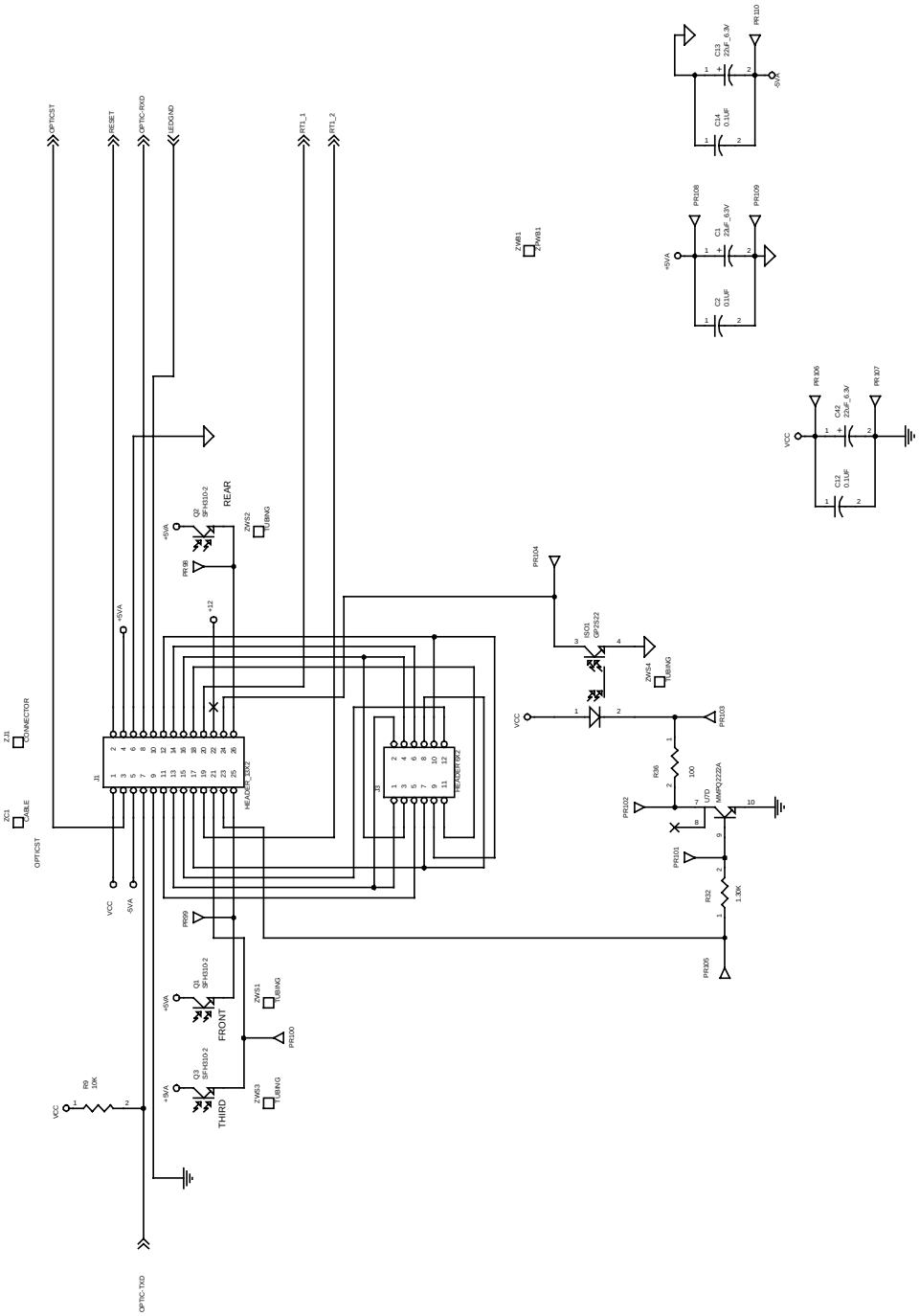
OPTICS MODULE - LED's Gasses & DAC Circuit Sheet 6



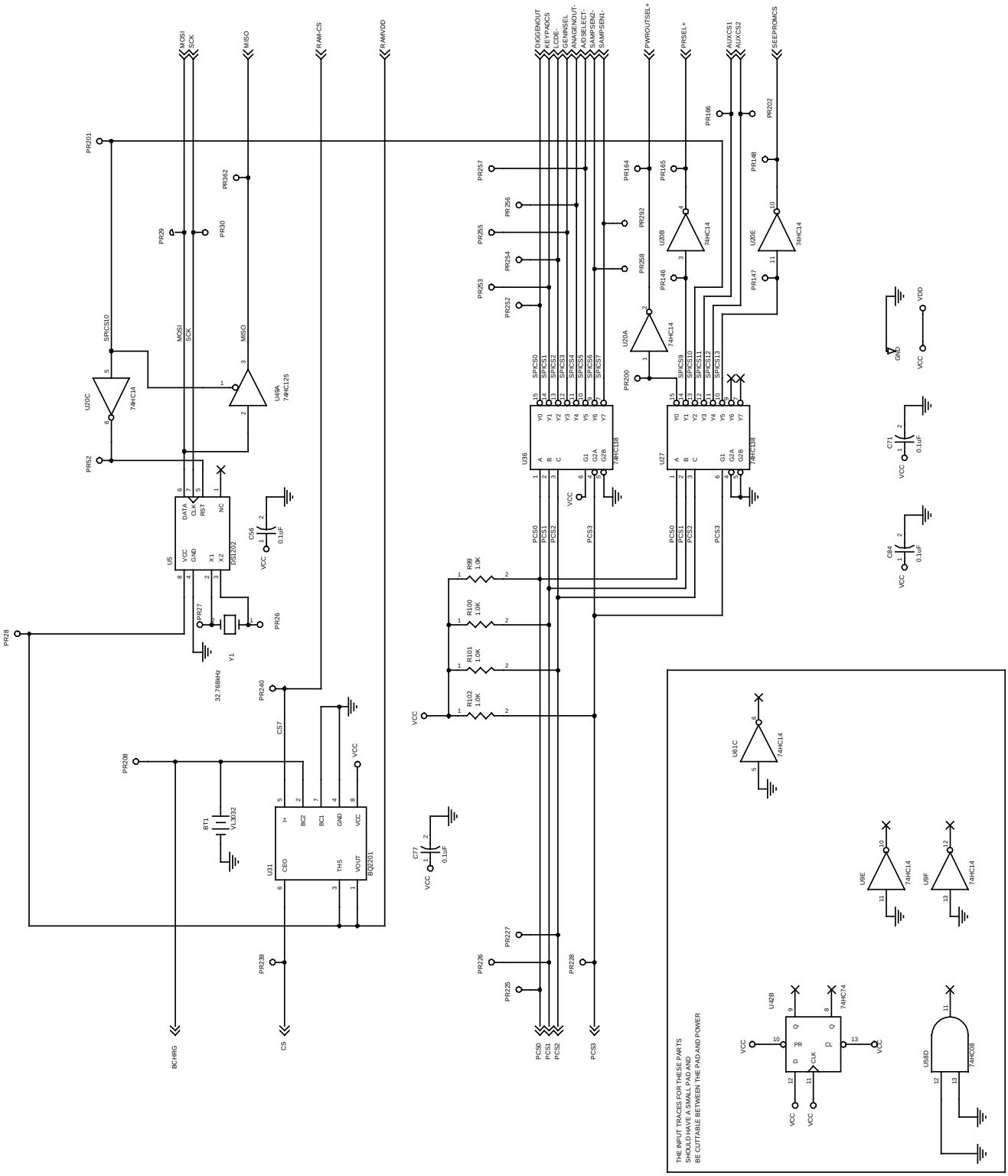
OPTICS MODULE - LED's & Lytes Circuit Sheet 7



OPTICS MODULE - Connector Circuit Sheet 8

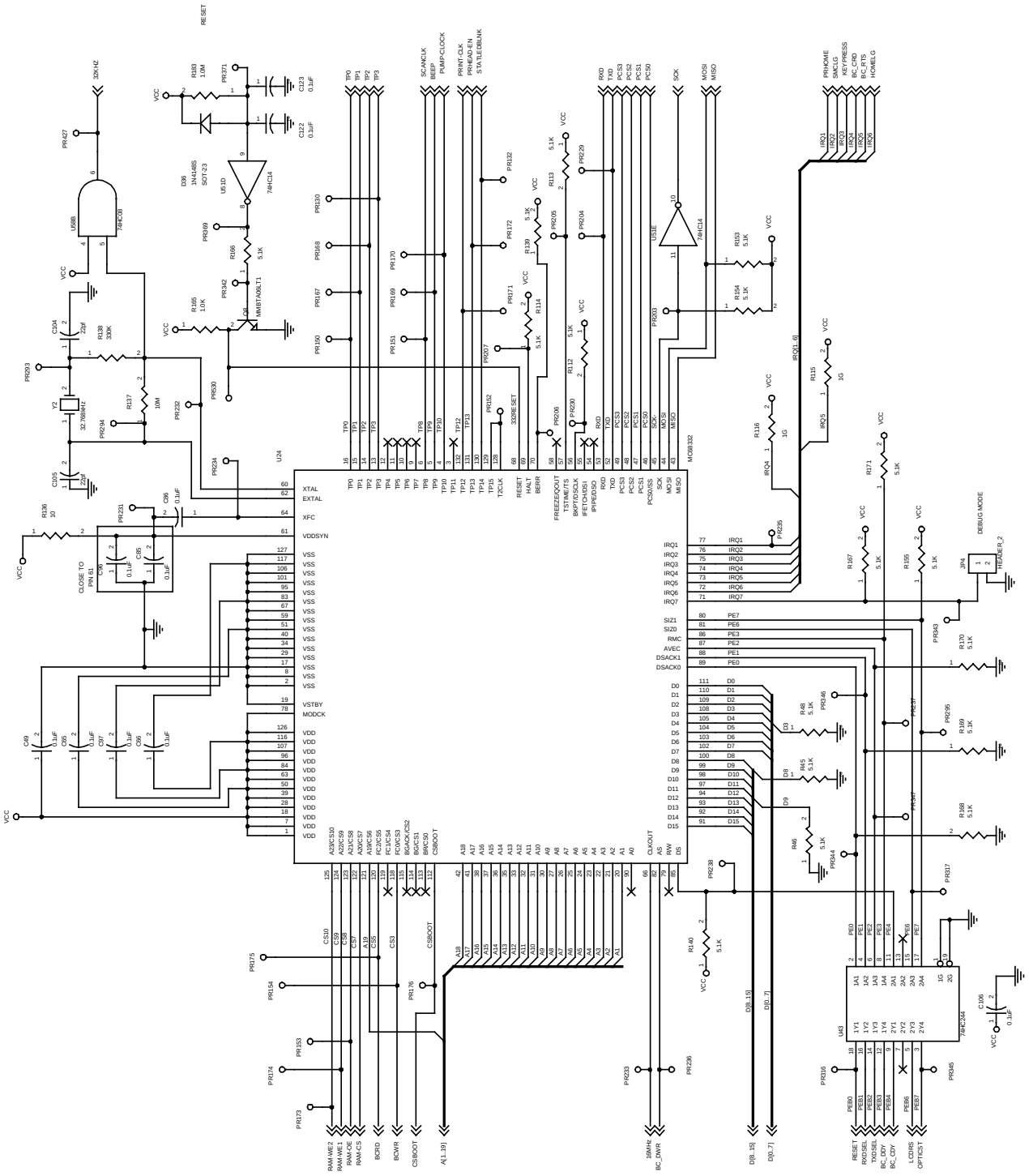


MAIN BOARD - RAM Battery Backup / Clock Sheet 1

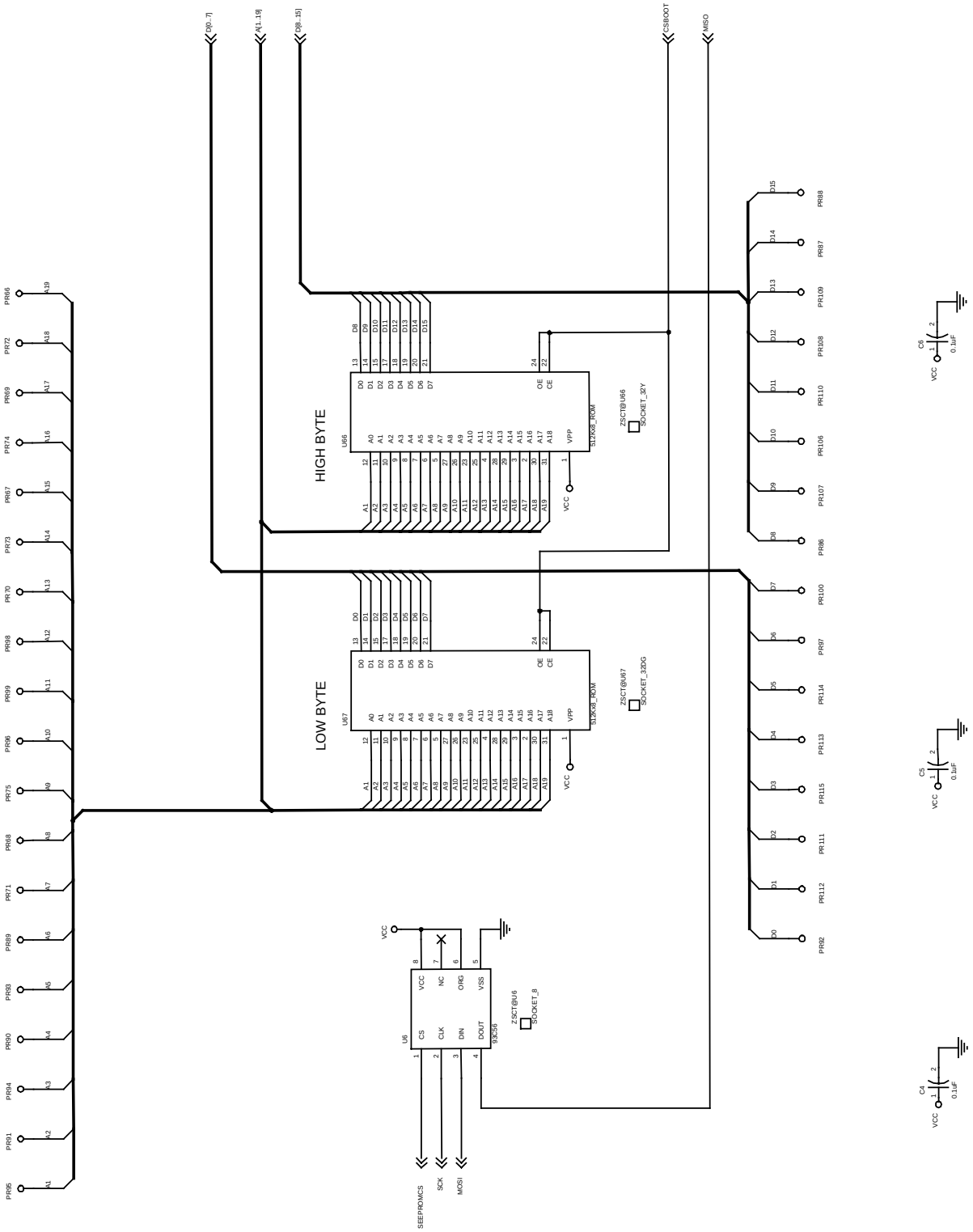


MAIN BOARD - Microprocessor

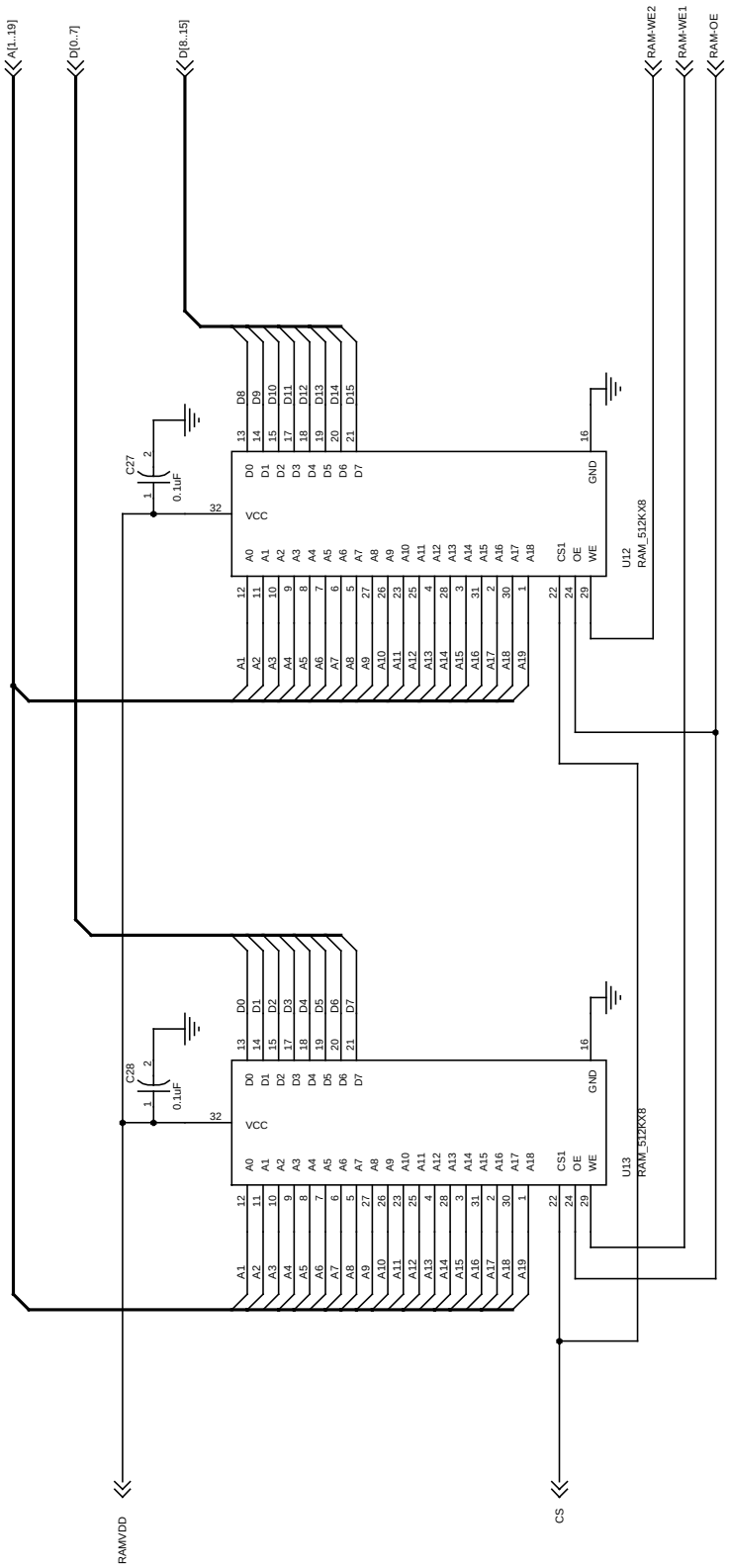
Sheet 2

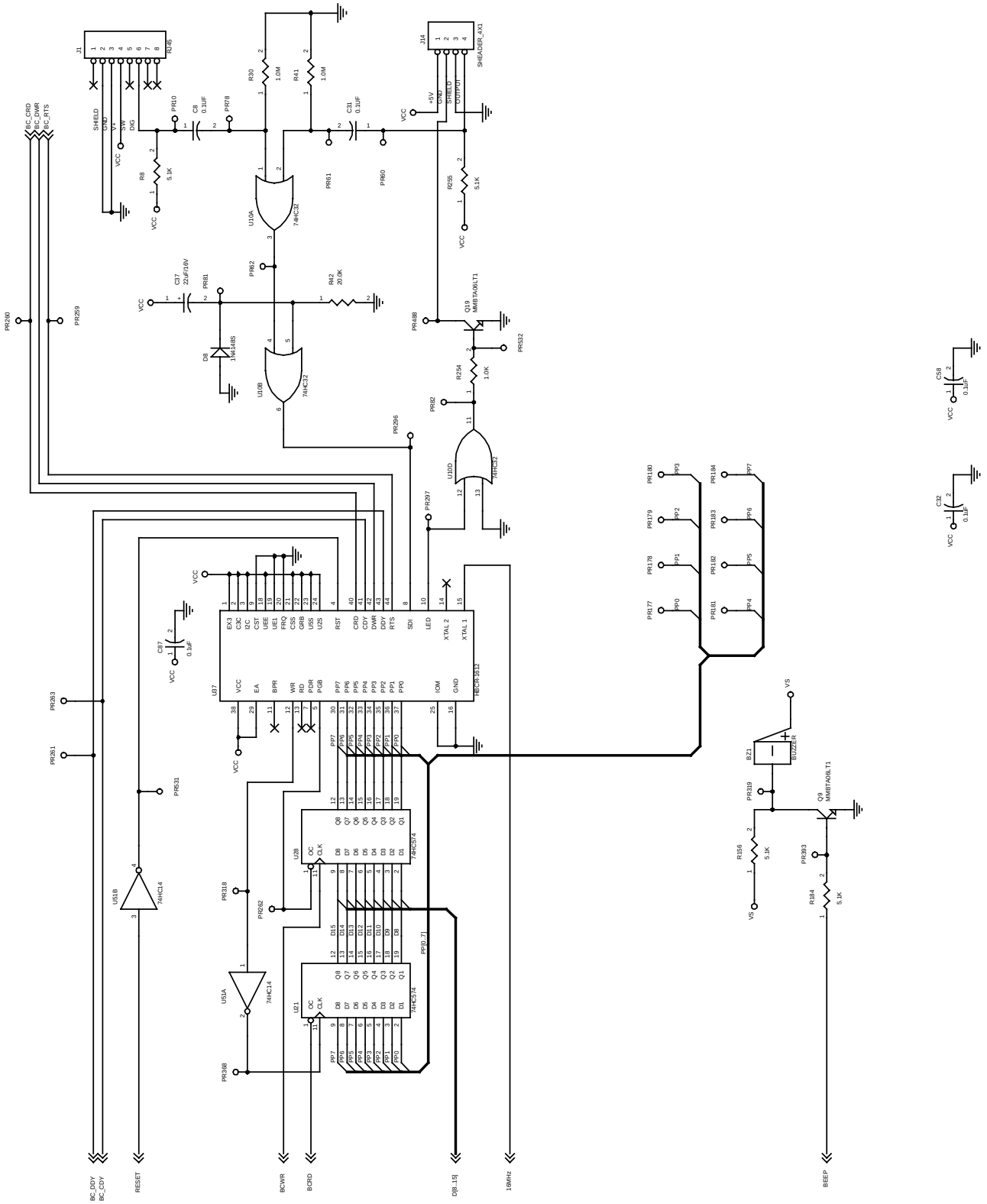


MAIN BOARD - 16 Bit EPROM Sheet 3



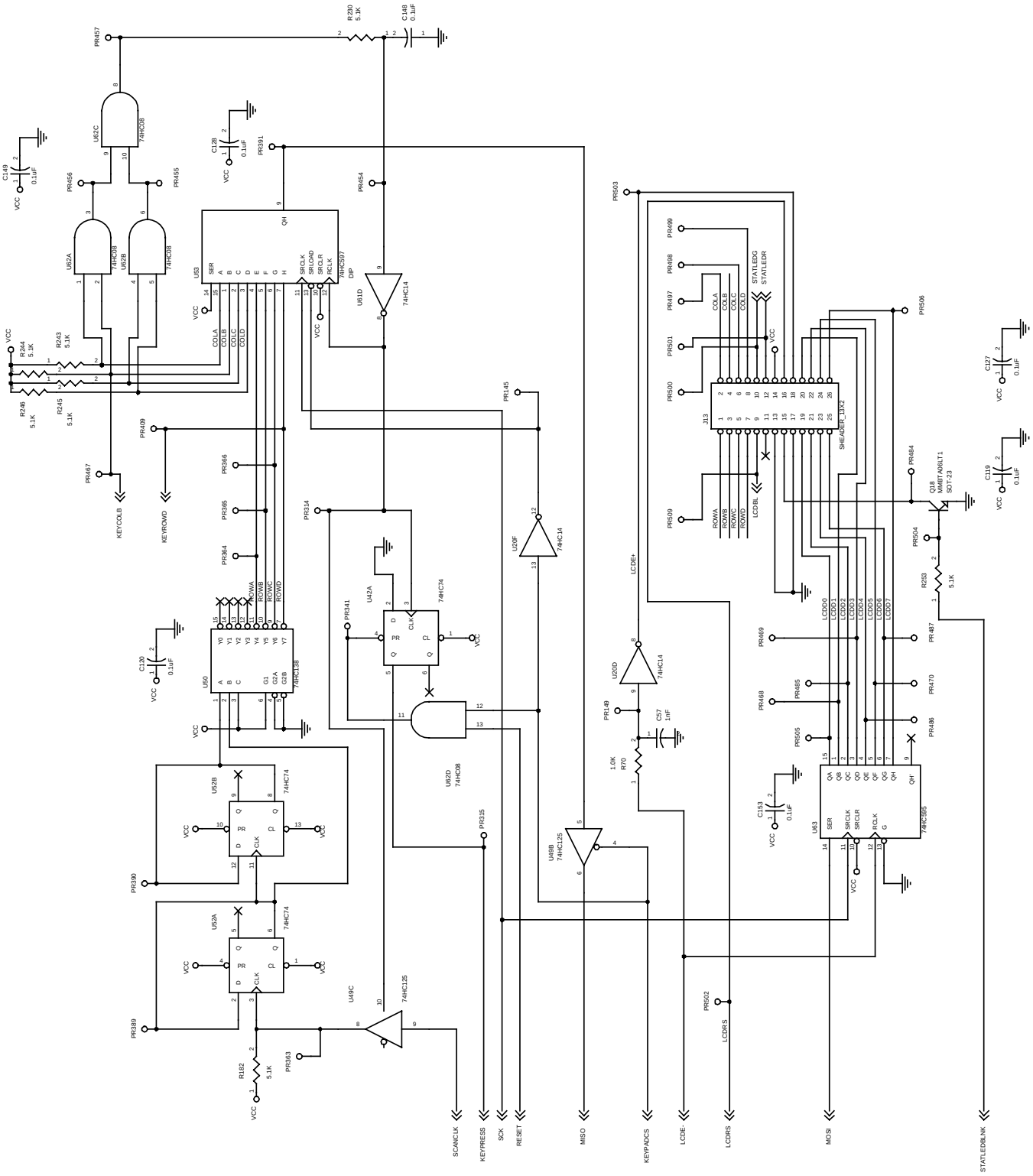
MAIN BOARD - 16 Bit RAM Sheet 4



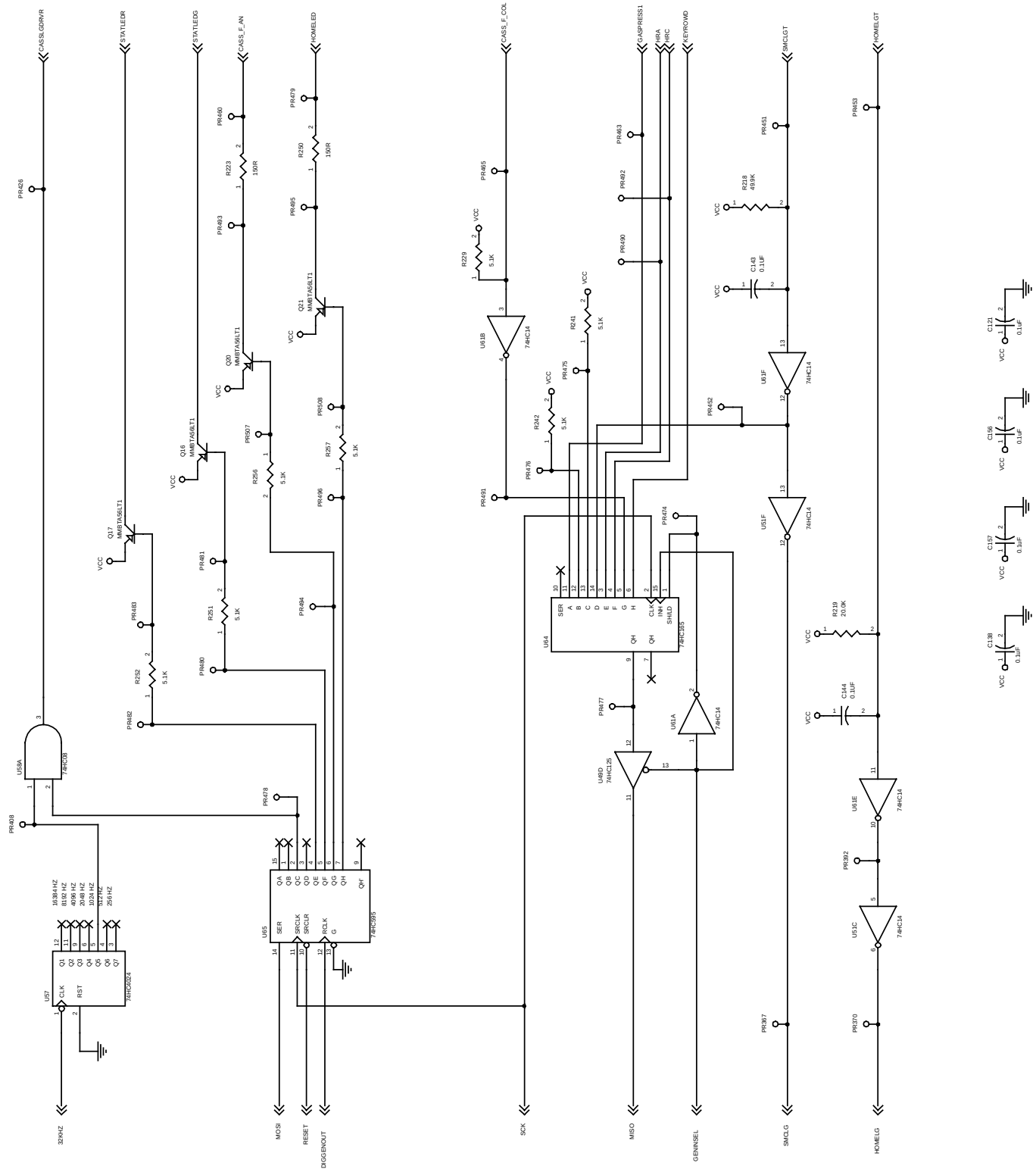

J1
RJ45
SHELD
GND
SW
DIG
VCC
PR10
C8
0.1UF
PR78
R30
1.0M
R41
1.0M
C31
0.1UF
J14
SHEADER_4X1
+5V
GND
SHIELD
OUTPUT
R8
5.1K
PR61
PR60
R255
5.1K
U10A
74HC32
PR62
C37
22uF/16V
PR81
R42
20.0K
D8
1N4148S
U10B
74HC32
PR260
PR259
PR488
Q10
MMBTA06LT1
PR532
R254
1.0K
PR82
U10D
74HC32
PR296
PR297
C38
0.1uF
C32
0.1uF
BC_CRD
BC_DWR
BC_RTS
U37
MBCM-1612
EX3
C3C
I2C
CST
UEE
USB
FRQ
CSS
GRB
U2S
RST
CRD
CDY
DWR
RTS
SDI
LED
XTAL 2
XTAL 1
EA
BPR
WR
RD
PDR
PGB
IOM
GND
C37
0.1uF
PR263
PR261
PR531
U51B
74HC14
U51A
74HC14
U20
74HC574
U21
74HC574
PR318
PR262
PR388
PP0..7
PR180
PR179
PR178
PR177
PR184
PR183
PR182
PR181
BZ1
BUZZER
PR319
Q9
MMBTA06LT1
R156
5.1K
PR393
R184
5.1K
V5
BC_DDY
BC_CDY
RESET
BCWR
BCRD
D[8..15]
10MHz
BEEP

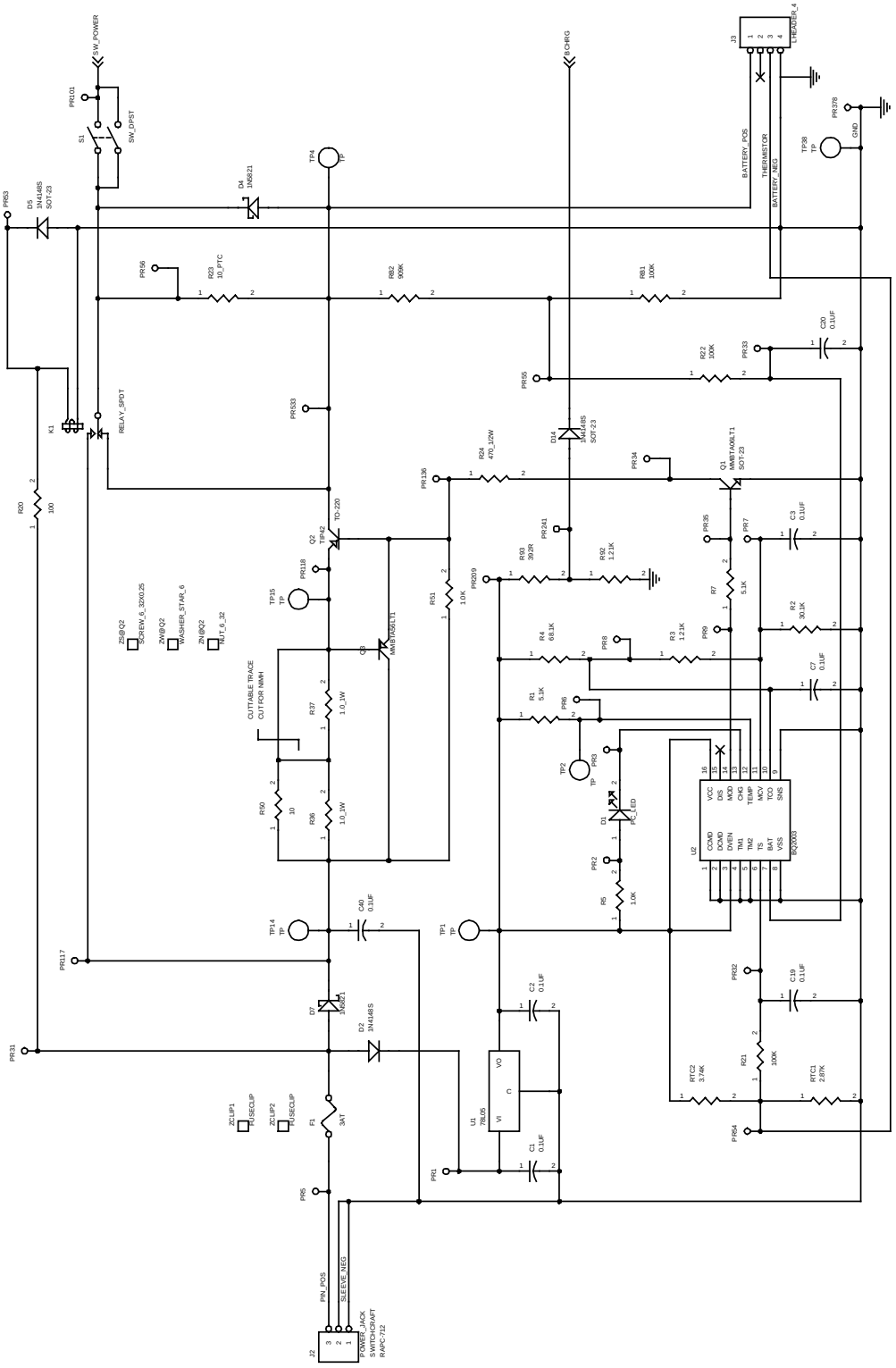
MAIN BOARD - Keypad and Display

Sheet 6

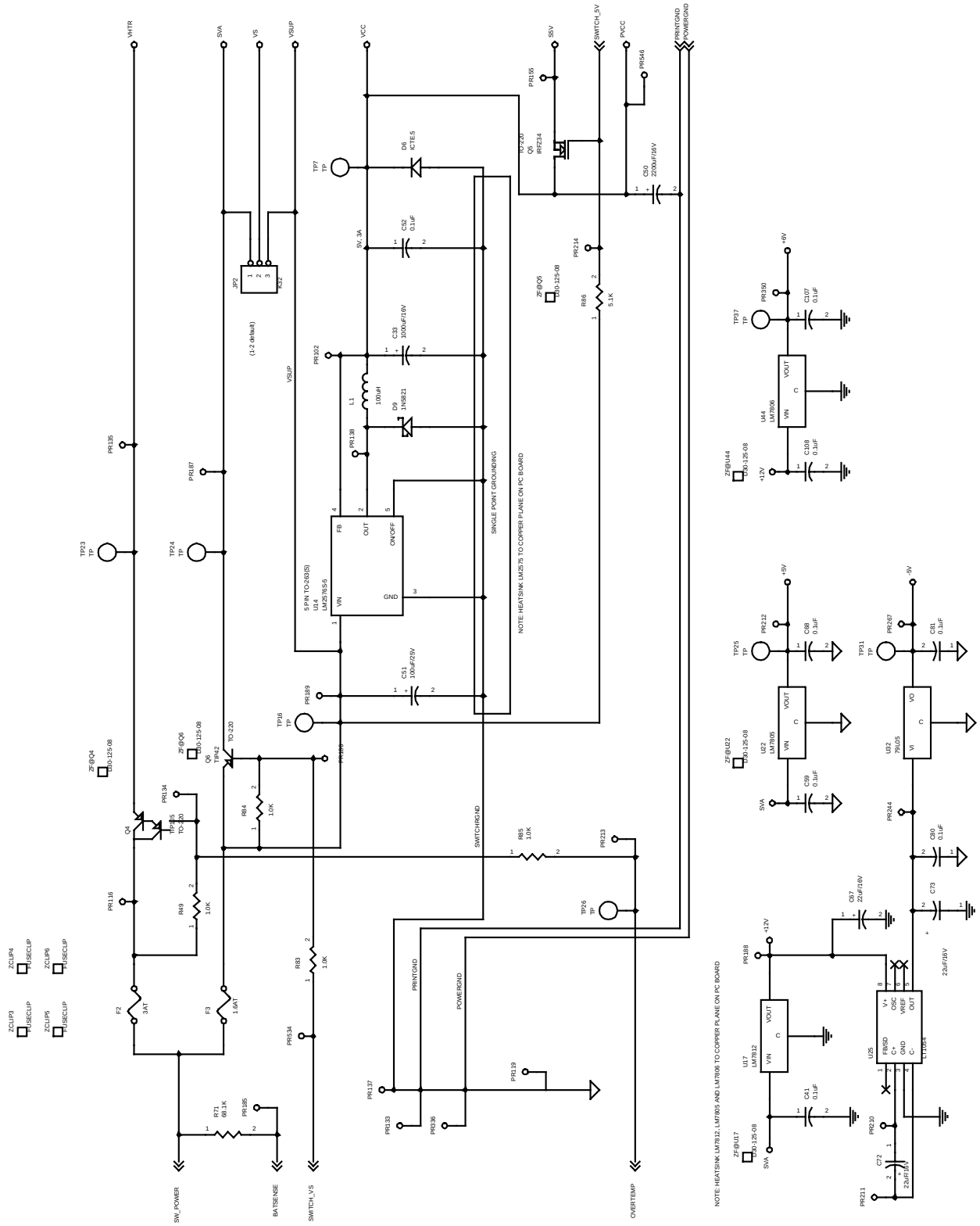


MAIN BOARD - Cassette Detection Logic Sheet 7

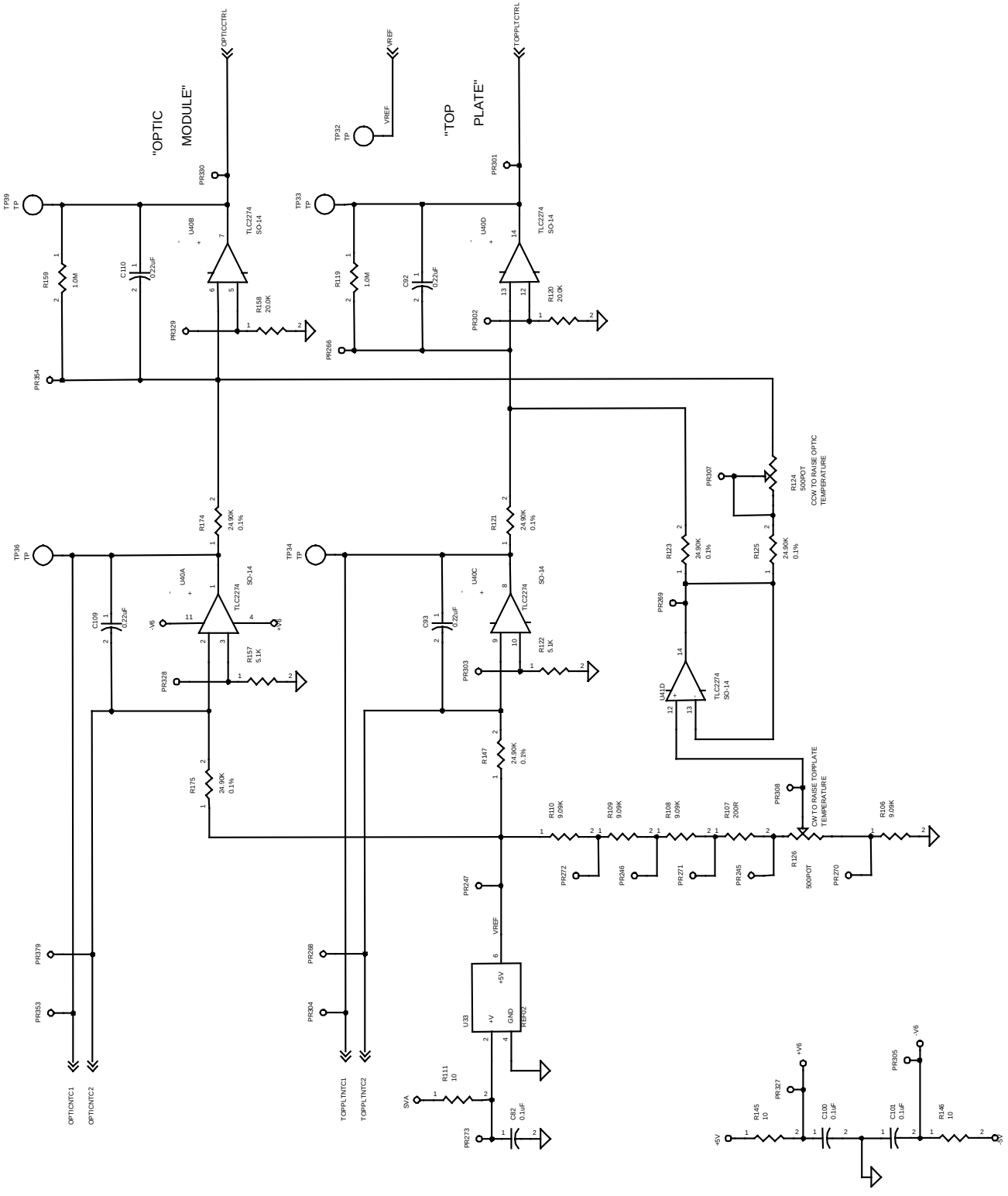



SW_POWER
SW_DPST
S1
PR101
D5
1N4148S
SOT-23
D4
1N5821
TP4
TP
PR53
PR56
R23
10_PTC
R82
909K
R81
100K
J3
HEADER_4
BATTERY_POS
THERMISTOR
BATTERY_NEG
PR378
GND
TP38
TP
C20
0.1UF
R22
100K
PR33
PR55
PR533
K1
RELAY_SPDT
D14
1N4148S
SOT-23
R24
470_1/2W
PR136
PR34
Q1
MMBTA06LT1
SOT-23
R20
100
Q2
TIP42
TO-220
PR35
PR7
C3
0.1UF
PR241
R93
392R
R92
1.21K
PR118
TP15
TP
R51
1.0K
PR219
R7
5.1K
R2
30.1K
ZS@Q2
SCREW_6_32X0.25
ZW@Q2
WASHER_STAR_6
ZB@Q2
NUT_6_32
Q3
MMBTA06LT1
R4
68.1K
PR8
R3
1.21K
PR9
CUTTABLE TRACE
CUTTER IMMI
R37
1.0_1W
R1
5.1K
PR6
C7
0.1UF
TP2
TP
PR3
R50
10
R36
1.0_1W
D1
PCC_LED
U2
BQ2003
VCC
DIS
MOD
CHG
TEMP
MOV
TCO
SNS
COMD
DCMD
DVEN
TM1
TM2
TS
BAT
VSS
PR2
R5
1.0K
TP14
TP
C40
0.1UF
TP1
TP
PR117
C2
0.1UF
PR32
C19
0.1UF
D7
1N5821
D2
1N4148S
R21
100K
RTC2
3.74K
RTC1
2.87K
PR54
PR31
ZCLIP1
TOUSECLIP
ZCLIP2
TOUSECLIP
F1
3AT
U1
78L05
VO
VI
C
C1
0.1UF
PR1
PR5
PIN_POS
SLEEVE_NEG
J2
POWER_JACK
SWITCHCRAFT
RAPC-712

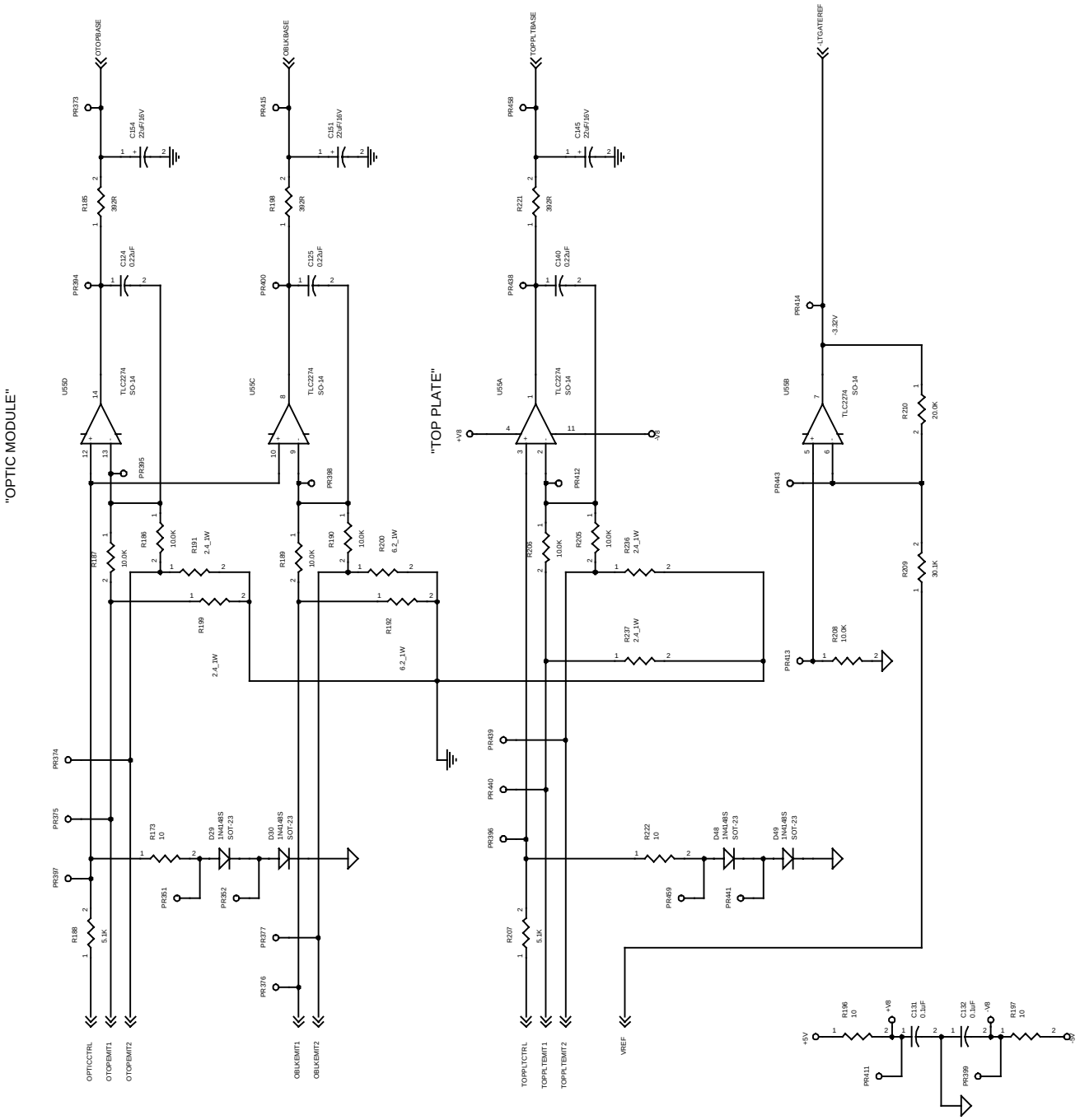
MAIN BOARD - Voltage Regulator Sheet 9



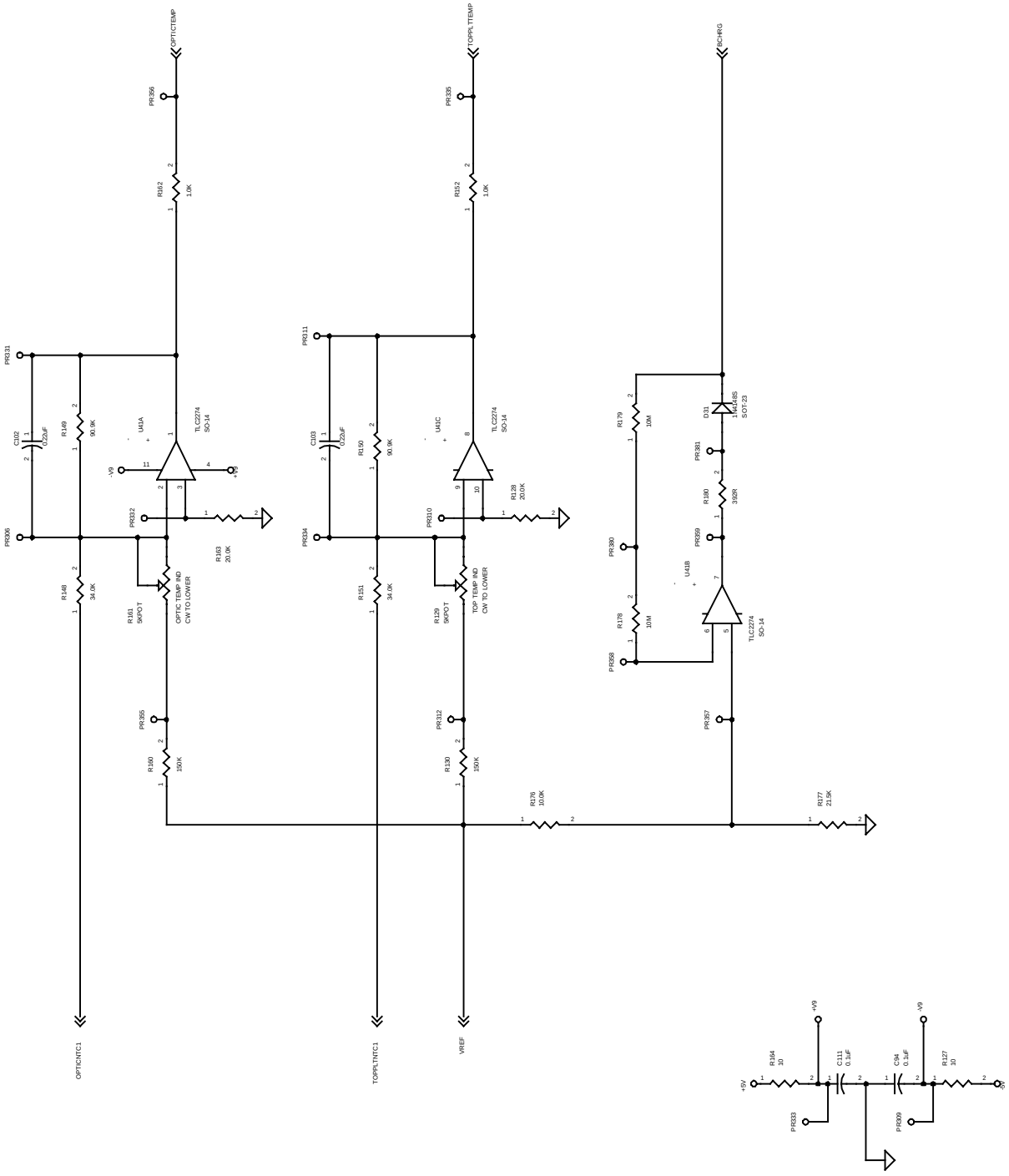
MAIN BOARD - SMC Temperature Control Sheet 10



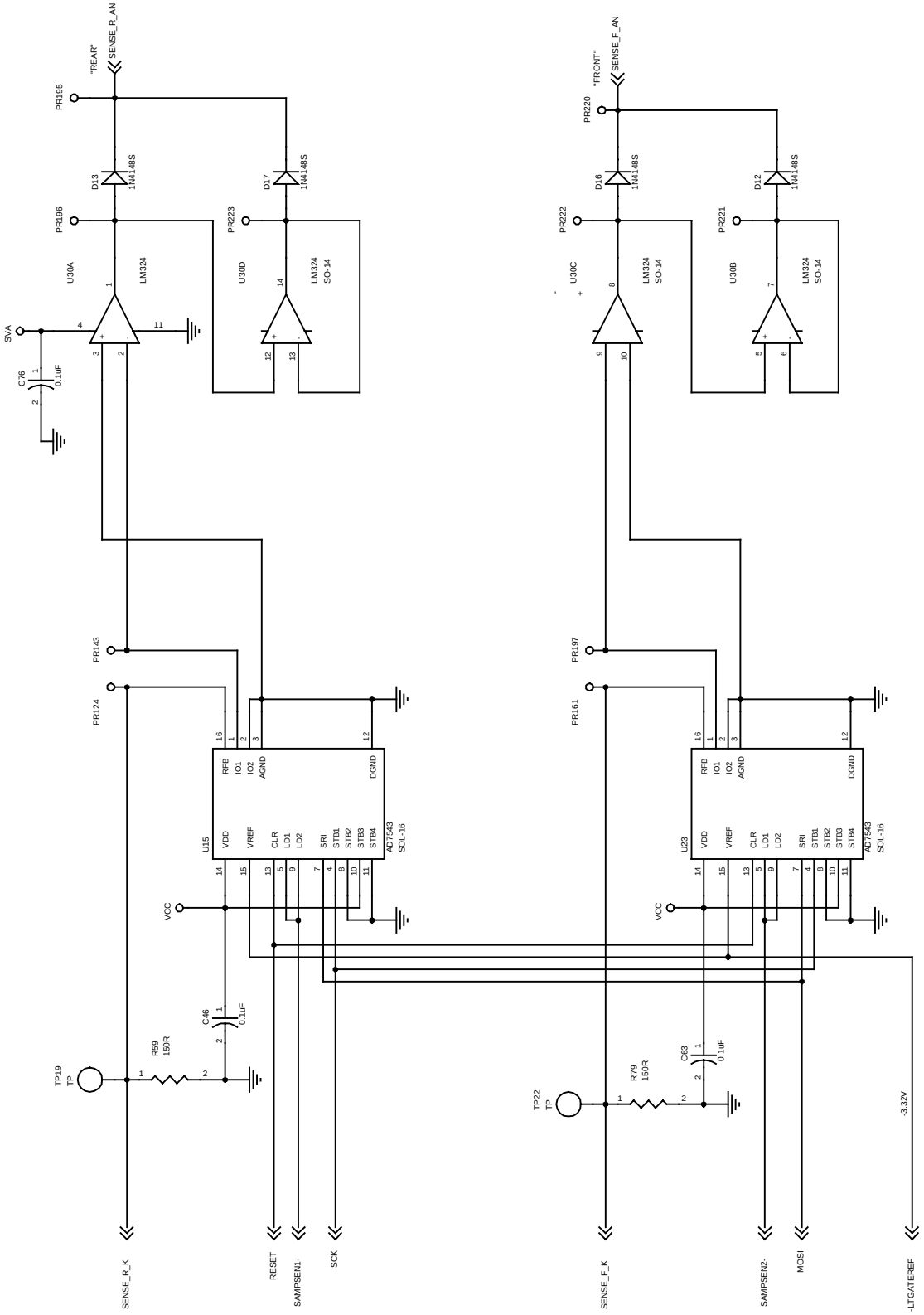
MAIN BOARD - SMC Heater Transistor Sheet 11



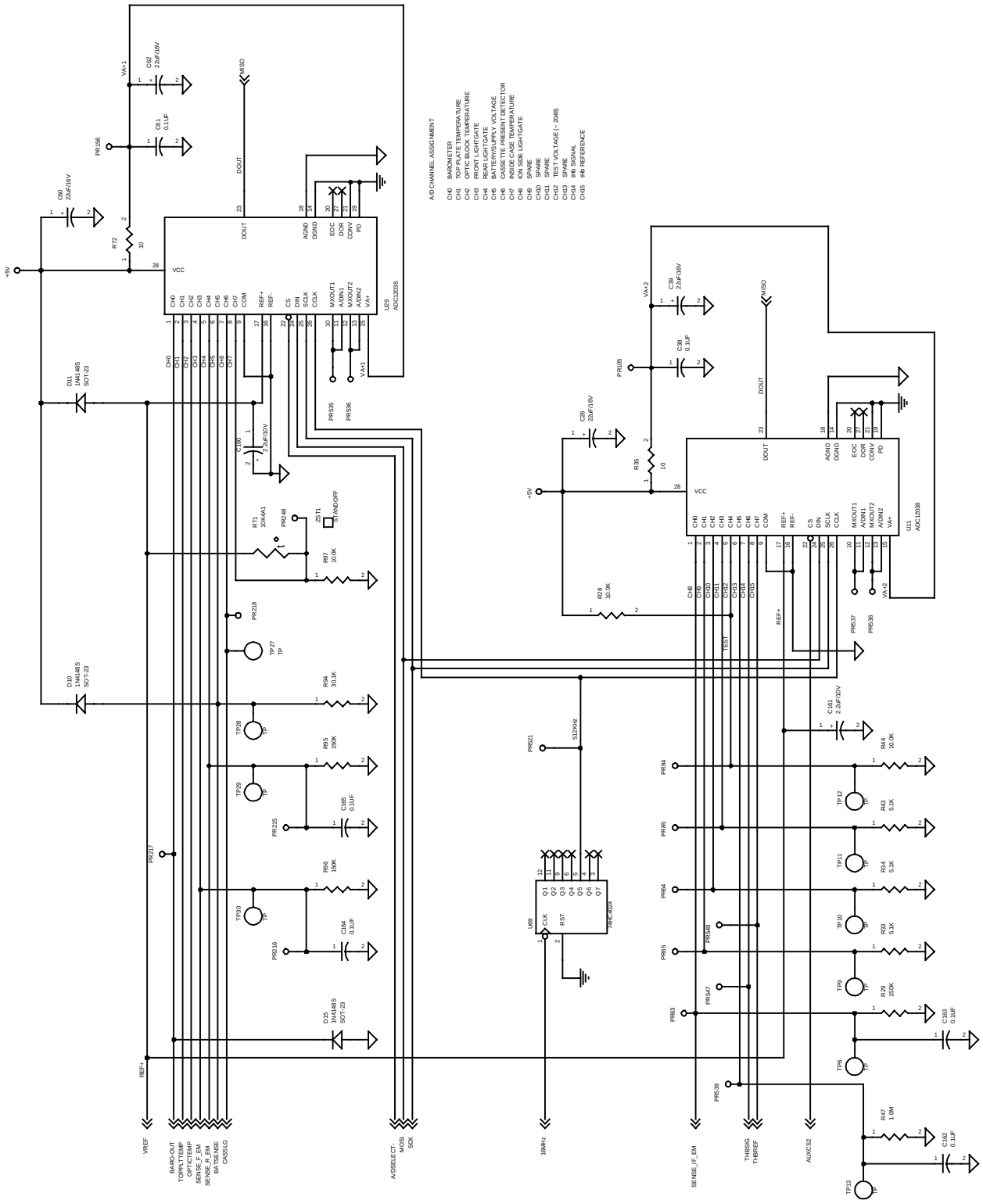
MAIN BOARD - SMC Heater Control Sheet 12

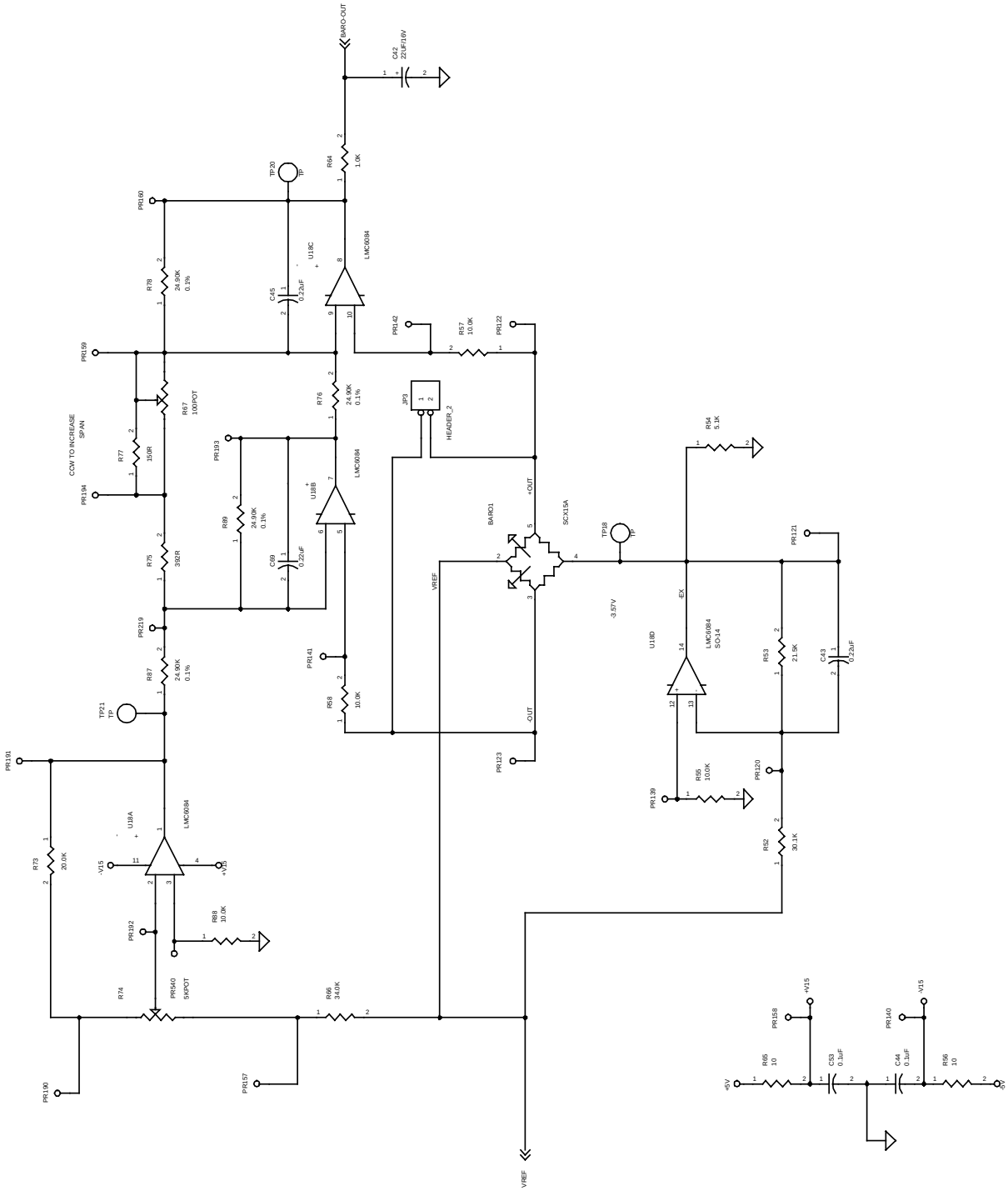


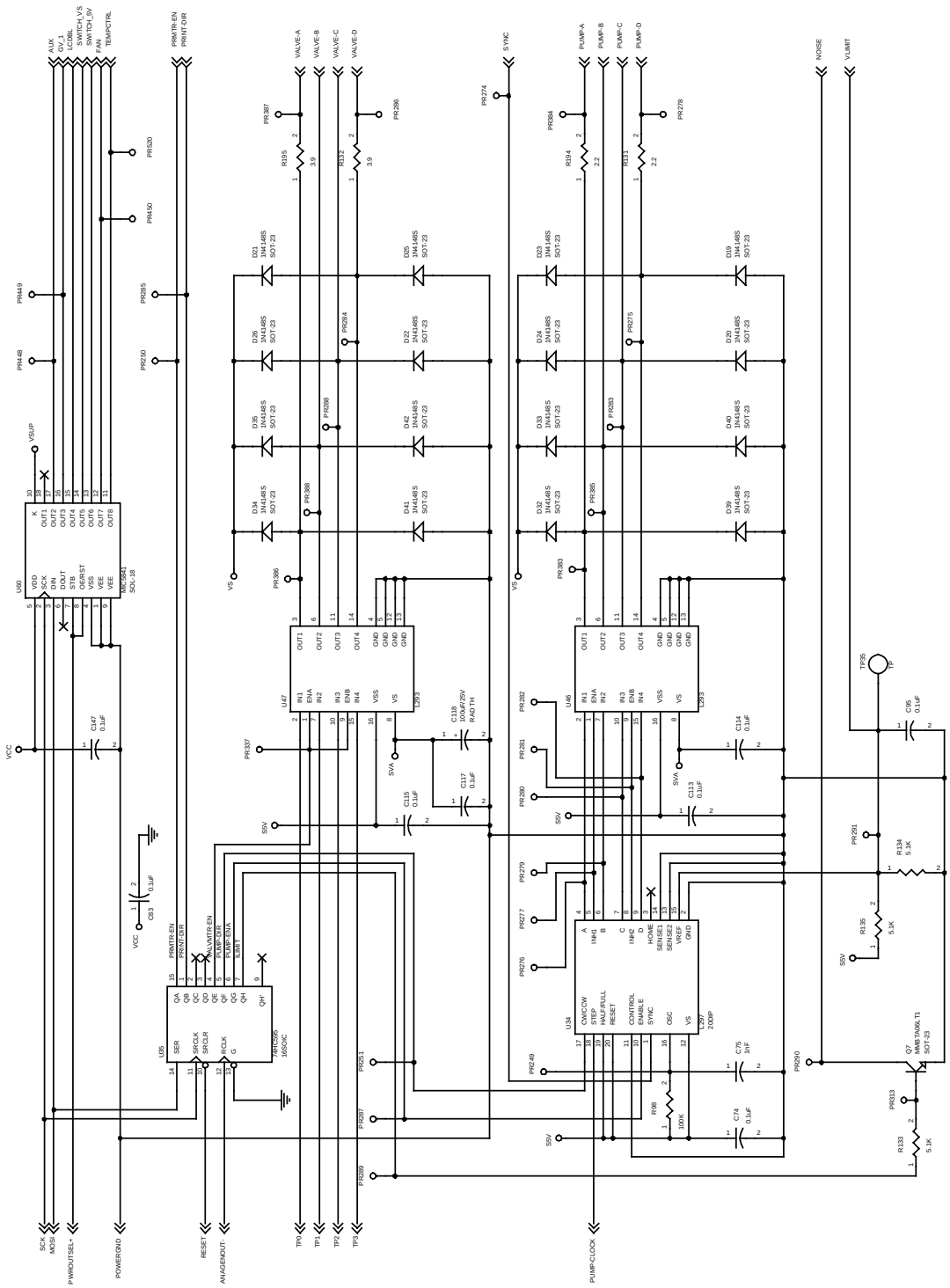
MAIN BOARD - Digital to Analog Converter Sheet 13

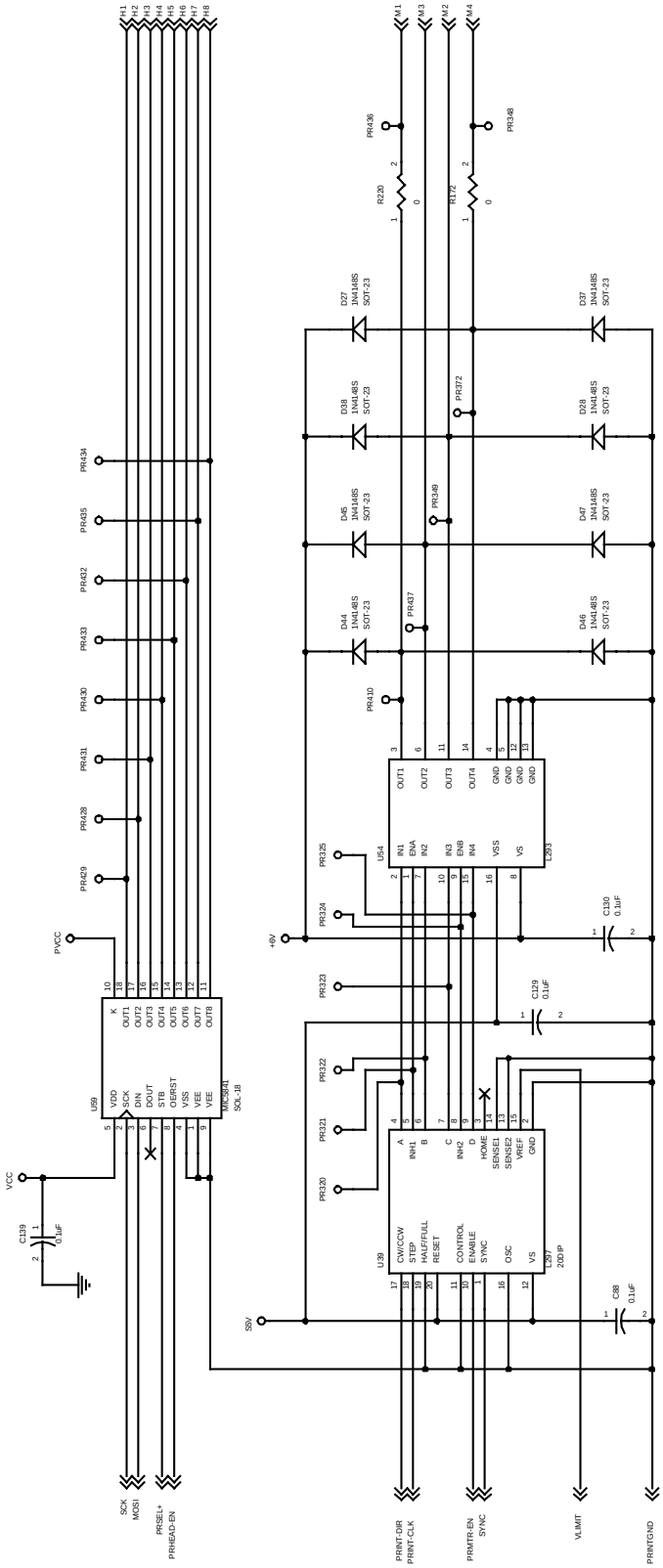


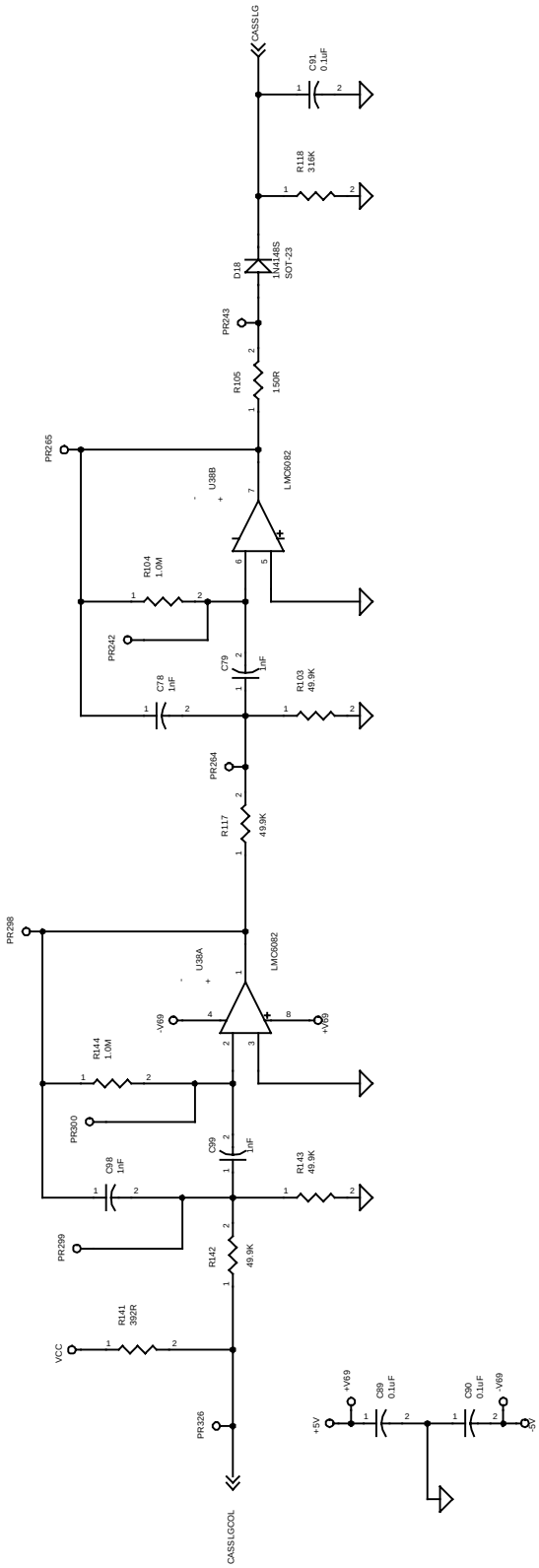
MAIN BOARD - Analog to Digital Converter Sheet 14

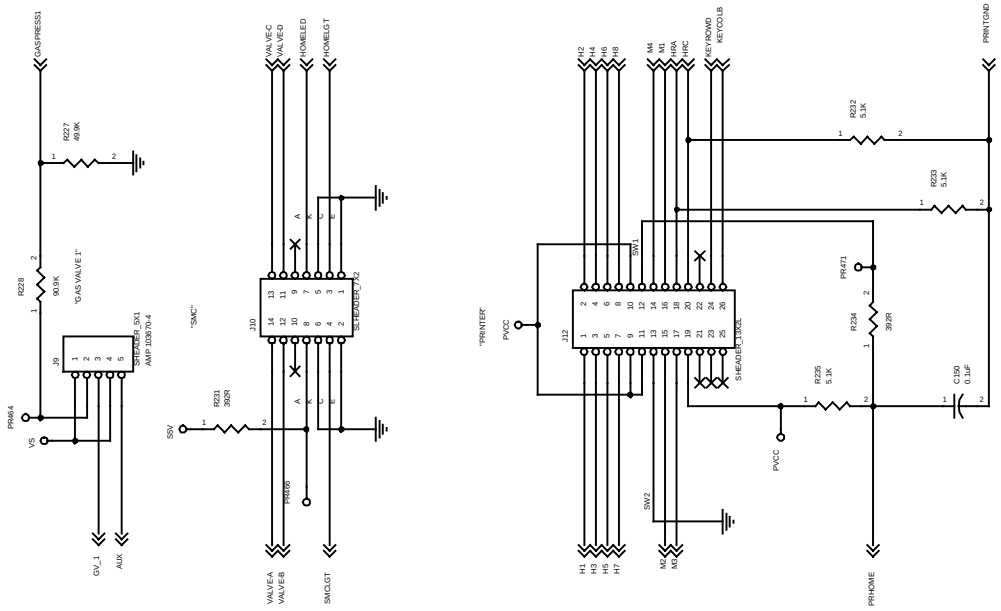


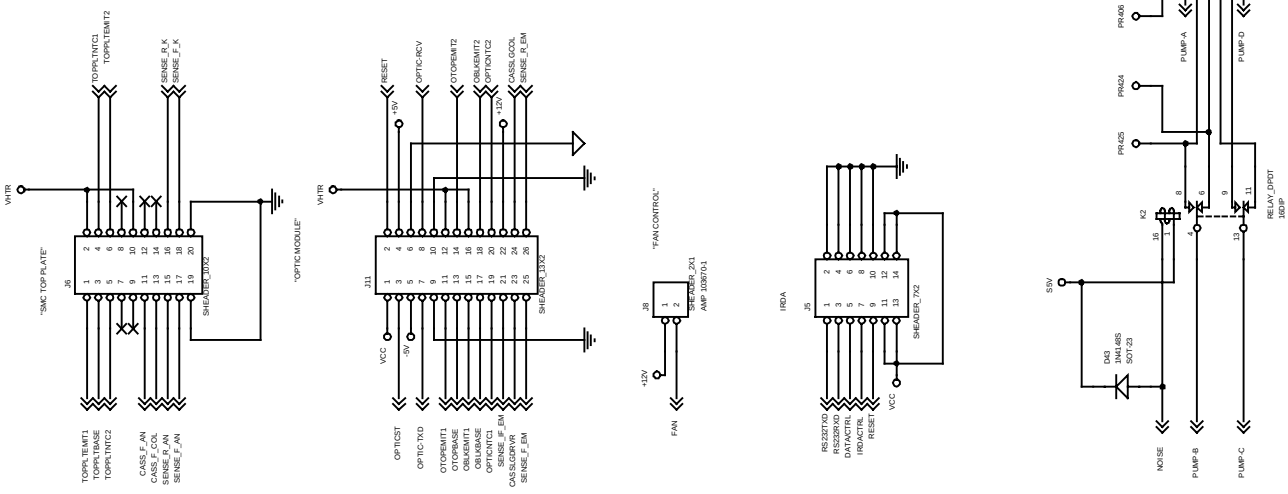

BARO-OUT
C42
22UF/16V
R64
1.0K
TP20
TP
PR160
R78
24.90K
0.1%
C45
0.22uF
U18C
LMC6084
PR142
R57
10.0K
PR122
PR159
R67
100POT
CCW TO INCREASE
SPAN
R77
150R
PR194
R76
24.90K
0.1%
JP3
HEADER_2
PR193
R89
24.90K
0.1%
C69
0.22uF
U18B
LMC6084
R75
392R
PR219
R87
24.90K
0.1%
TP21
TP
PR141
R58
10.0K
PR101
U18A
LMC6084
R73
20.0K
-V15
+V15
PR192
R88
10.0K
PR140
R74
PR190
PR157
R66
34.0K
VREF
+OUT
-OUT
BARO1
SCX15A
TP18
TP
-EX
-3.57V
R54
5.1K
PR121
U18D
LMC6084
SO-14
R53
21.9K
C43
0.22uF
PR123
R55
100K
PR139
PR120
R52
30.1K
PR158
R86
10
C53
0.1uF
C44
0.1uF
R56
10
+5V
-5V



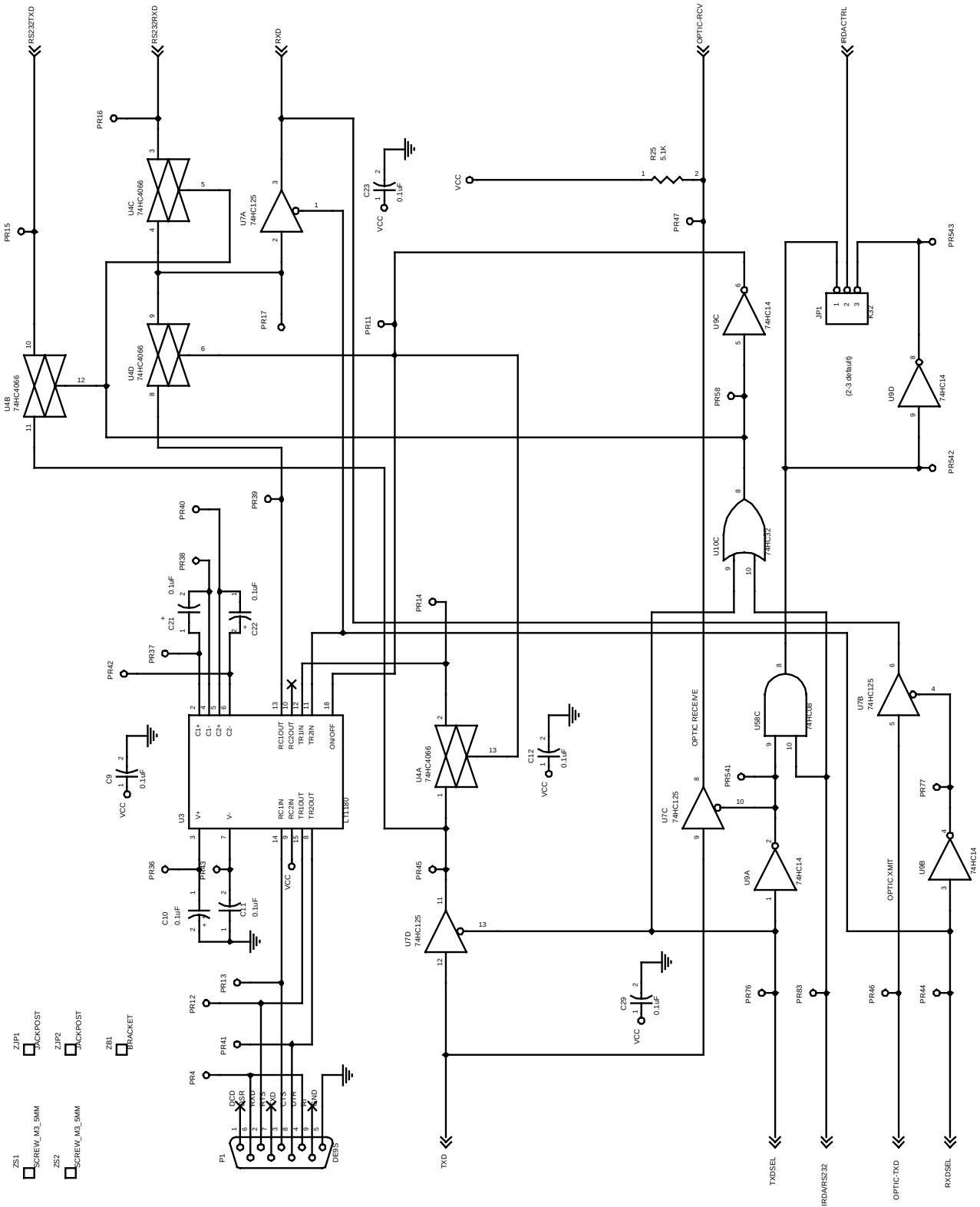

H1
H2
H3
H4
H5
H6
H7
H8
M1
M3
M2
M4
PR436
PR348
R220
R172
D27 1N4148S SOT-23
D37 1N4148S SOT-23
D38 1N4148S SOT-23
D28 1N4148S SOT-23
PR372
PR434
PR435
PR432
PR433
PR430
PR431
PR428
PR429
PR349
D45 1N4148S SOT-23
D47 1N4148S SOT-23
PR437
D44 1N4148S SOT-23
D46 1N4148S SOT-23
PR410
U54
L293
OUT1
OUT2
OUT3
OUT4
GND
IN1
ENA
IN2
IN3
ENB
IN4
VSS
VS
PR325
PR324
PR323
PR322
PR321
PR320
+8V
C130 0.1uF
C129 0.1uF
PVCC
U59
MAX3841
SCL-18
K
OUT1
OUT2
OUT3
OUT4
OUT5
OUT6
OUT7
OUT8
VDD
SCK
DIN
DOUT
STB
OVERST
VSS
VEE
VCC
C139 0.1uF
U39
L297 20DIP
A
INH1
B
C
INH2
D
HOME
SENSE1
SENSE2
VREF
GND
CW/CCW
STEP
HALF/FULL
RESET
CONTROL
ENABLE
SYNC
OSC
VS
5BV
C88 0.1uF
SCK
MOSI
PRSEL+
PRHEAD-EN
PRINT-DIR
PRINT-CLK
PRMTR-EN
SYNC
VLIMIT
PRINTGND


CASSLG
C91
0.1uF
R118
316K
D18
1N4148S
SOT-23
PR243
R105
150R
PR265
U38B
LMC6082
R104
1.0M
PR242
C79
1nF
C78
1nF
R103
49.9K
PR264
R117
49.9K
PR298
U38A
LMC6082
-V69
+V69
R144
1.0M
PR300
C99
1nF
C98
1nF
R143
49.9K
PR299
R142
49.9K
R141
392R
VCC
PR326
CASSLGCOL
+V69
C89
0.1uF
C90
0.1uF
-V69
+5V
-5V

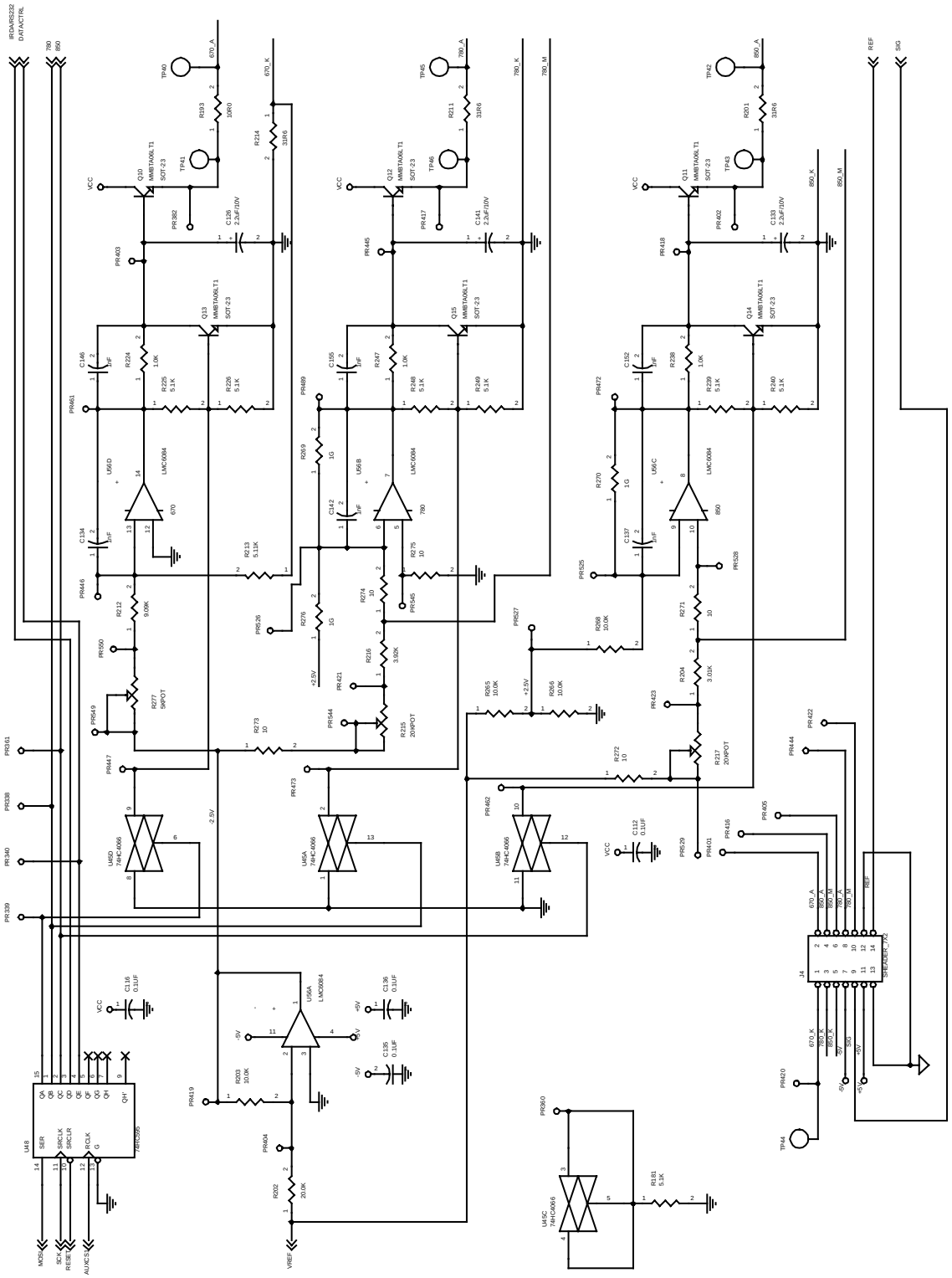

"GASPRESS1"
R227 49.9K
R228 90.9K
"GAS VALVE 1"
J9
SHEADER_5X1
AMP 1038 70-4
PR464
VS
GV_1
AUX
"SMC"
R231 392R
PR465
VALVE A
VALVE B
SMCLGT
"VALVE C"
"VALVE D"
"HOMELED"
"HOMELGT"
J10
SHEADER_7X2
"PRINTER"
PVCC
J12
SHEADER_13X2
SW1
SW2
H1
H2
H3
H4
H5
H6
H7
H8
M1
M2
M3
M4
PRHOME
PRHRA
PRHRC
KEYROWD
KEYCOLB
PRINTGND
R232 5.1K
R233 5.1K
R234 392R
PR471
R235 5.1K
C150 0.1uF


"SMC TOP PLATE"
J6
SHEADER_10X2
TOPPLTMT1
TOPPLTMT2
TOPPLTNTC1
TOPPLTNTC2
SENSE_R_AN
SENSE_F_AN
CASS_F_CON
CASS_R_CON
SENSE_F_K
SENSE_R_K
VHTR
"OPTIC MODULE"
J11
SHEADER_13X2
OPTICTXD
OPTICRCV
OTOPEMIT1
OTOPBASE
OBLKEMIT1
OBLKBASE
OPTICTC1
OPTICTC2
SENSE_F_EM
SENSE_R_EM
CASSLGDRVR
CASSLGCOL
RESET
+5V
-5V
VCC
+12V
"FAN CONTROL"
J8
SHEADER_2X1
AMP 103970-1
+12V
FAN
IRDA
J5
SHEADER_7X2
RS232TXD
RS232RXD
DATACTRL
IRDACTRL
RESET
"PUMP MOTOR"
J7
SHEADER_6X1
AMP 103970-5
PR407
PR406
PR424
PR425
PUMP-A
PUMP-D
K2
RELAY_DPDT
16DIP
D42
1N4148S
SOT-23
5SV
NO/SE
PUMP-B
PUMP-C

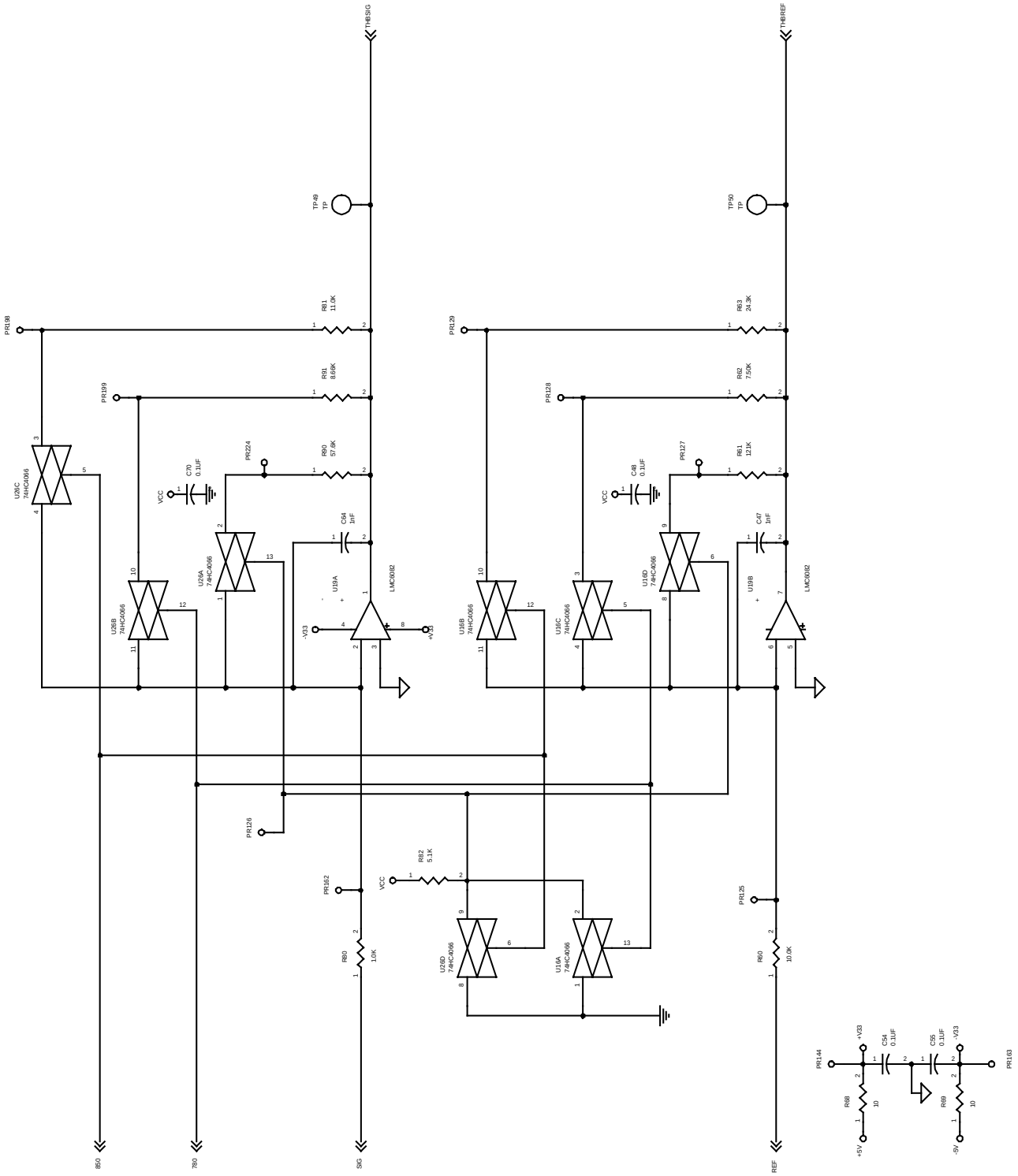
MAIN BOARD - Serial Interface Sheet 20



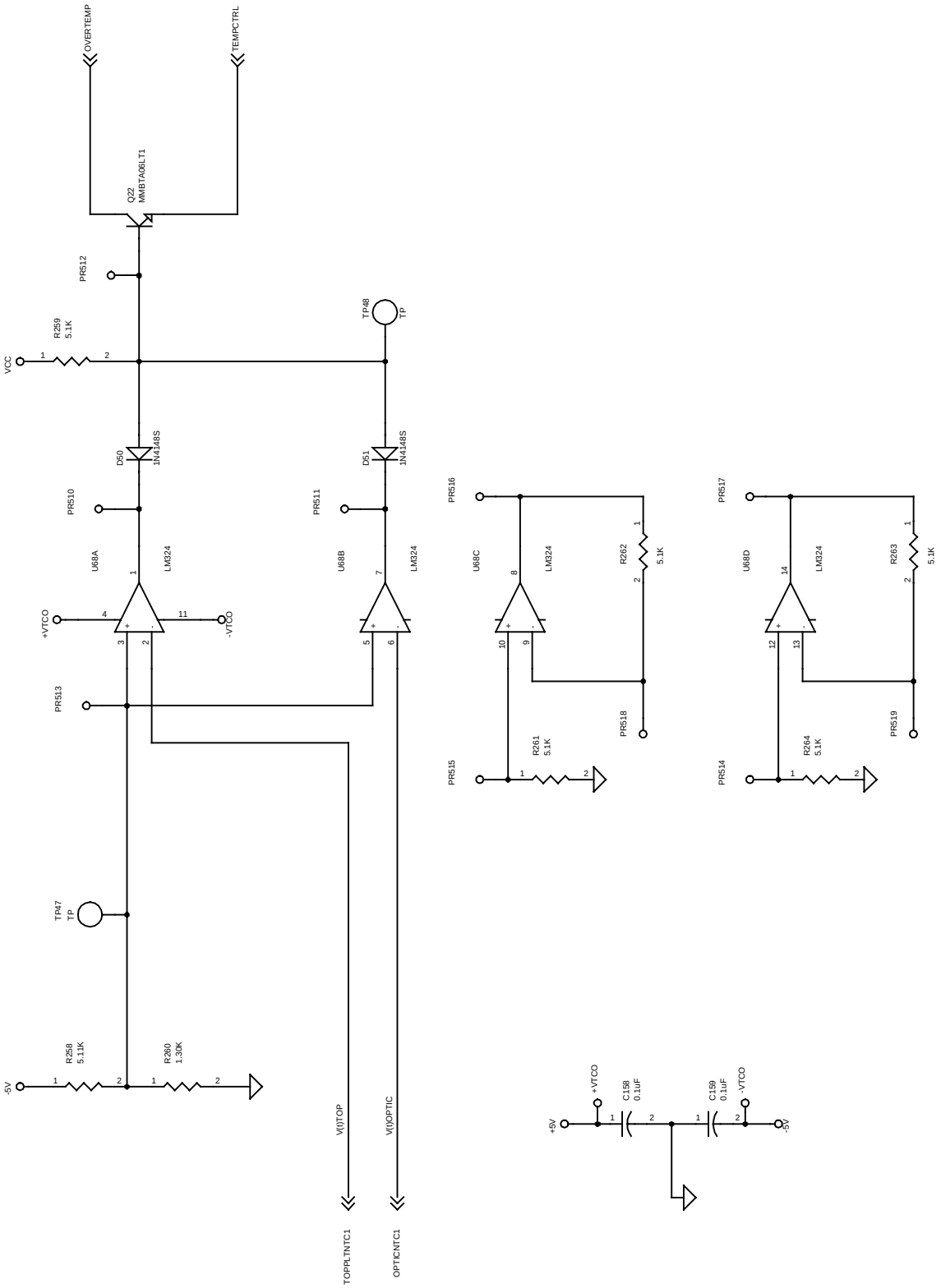
MAIN BOARD - tHb / SO2 Laser / LED Driver Sheet 21



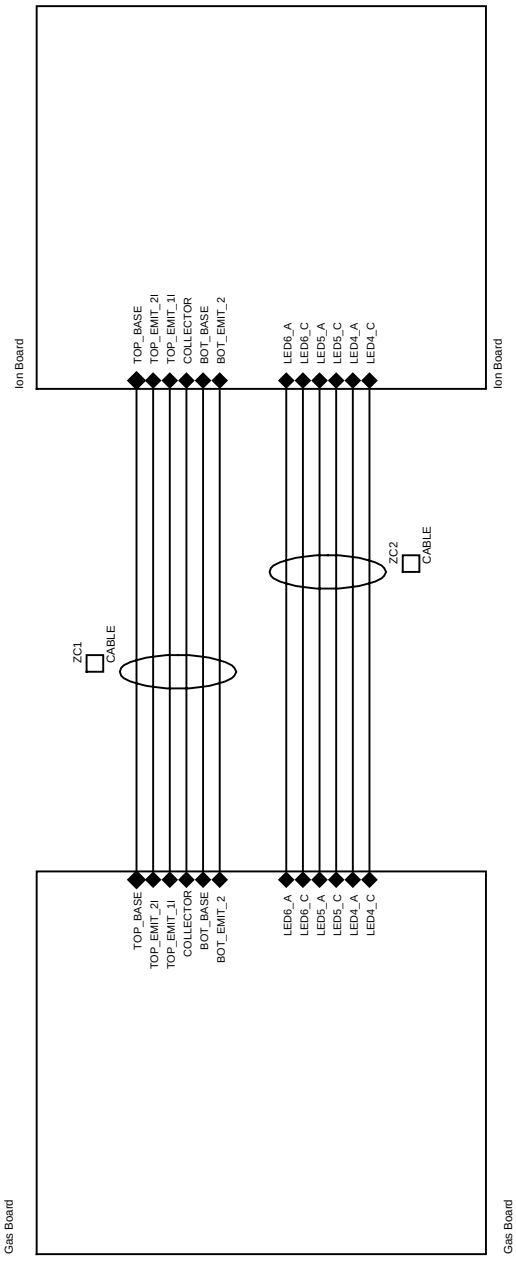
MAIN BOARD - tHb / SO2 Amplifier Sheet 22

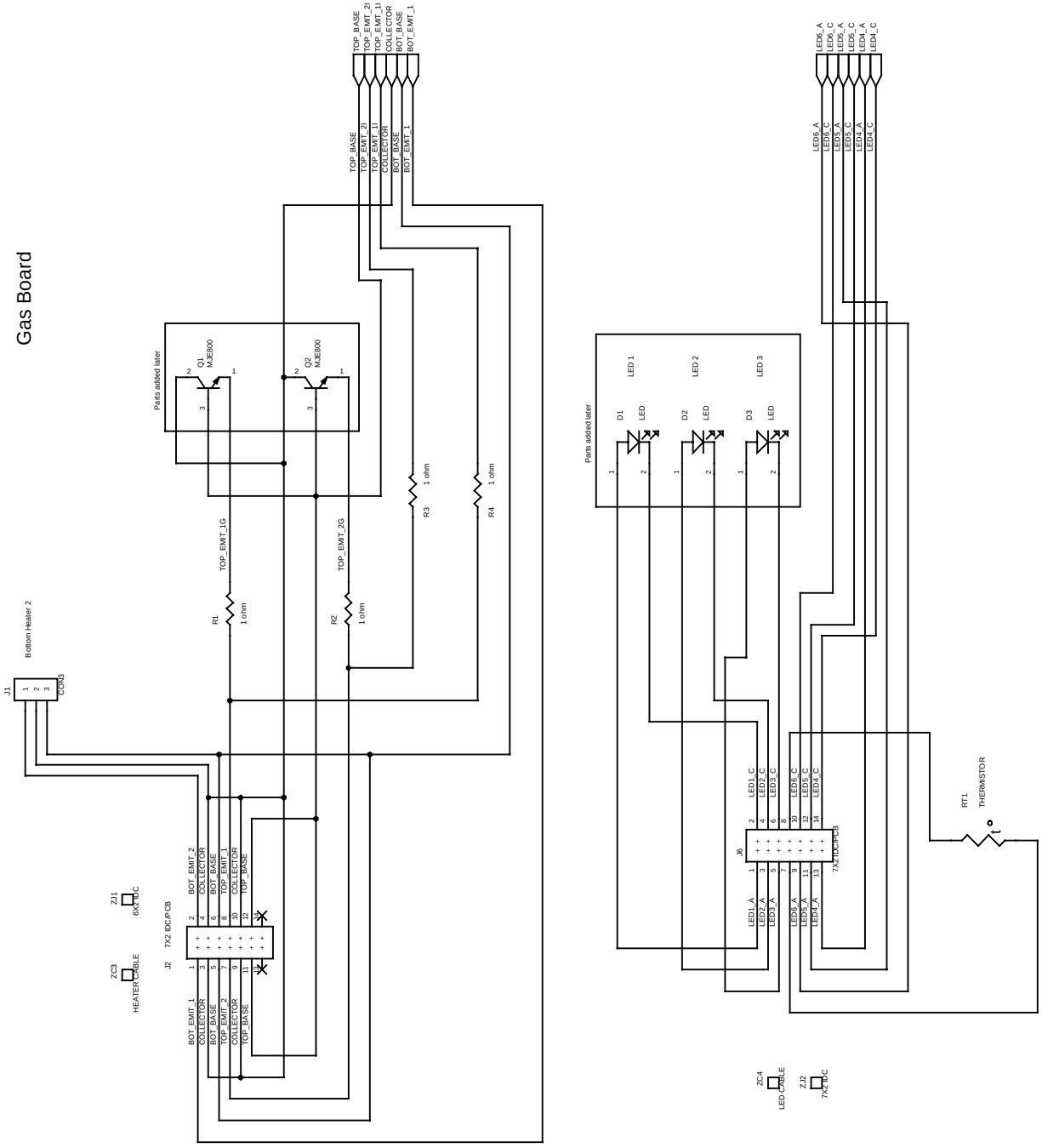


MAIN BOARD - Overtemperature Protection Sheet 23



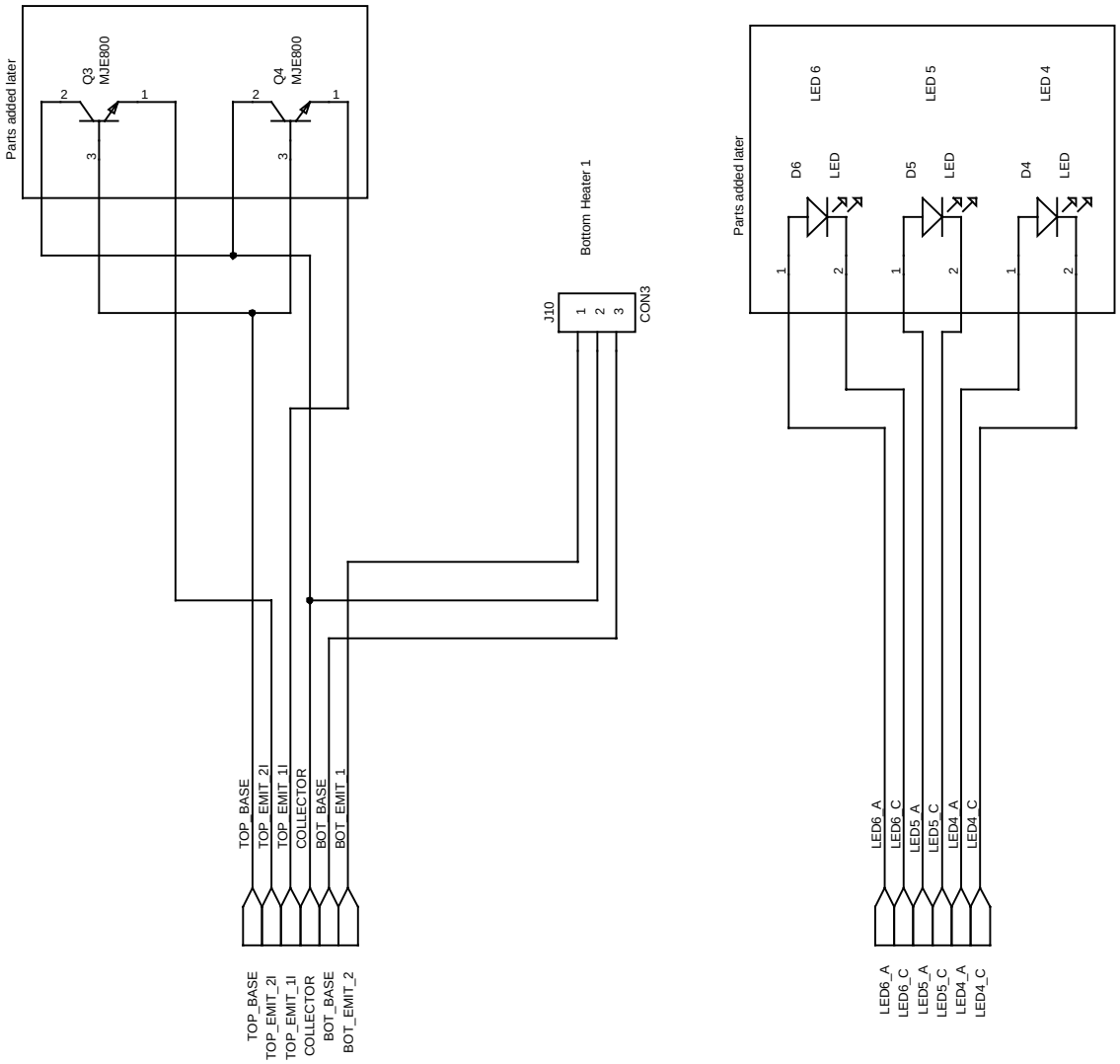
OPTICS MODULE - Interconnect Board Sheet 1



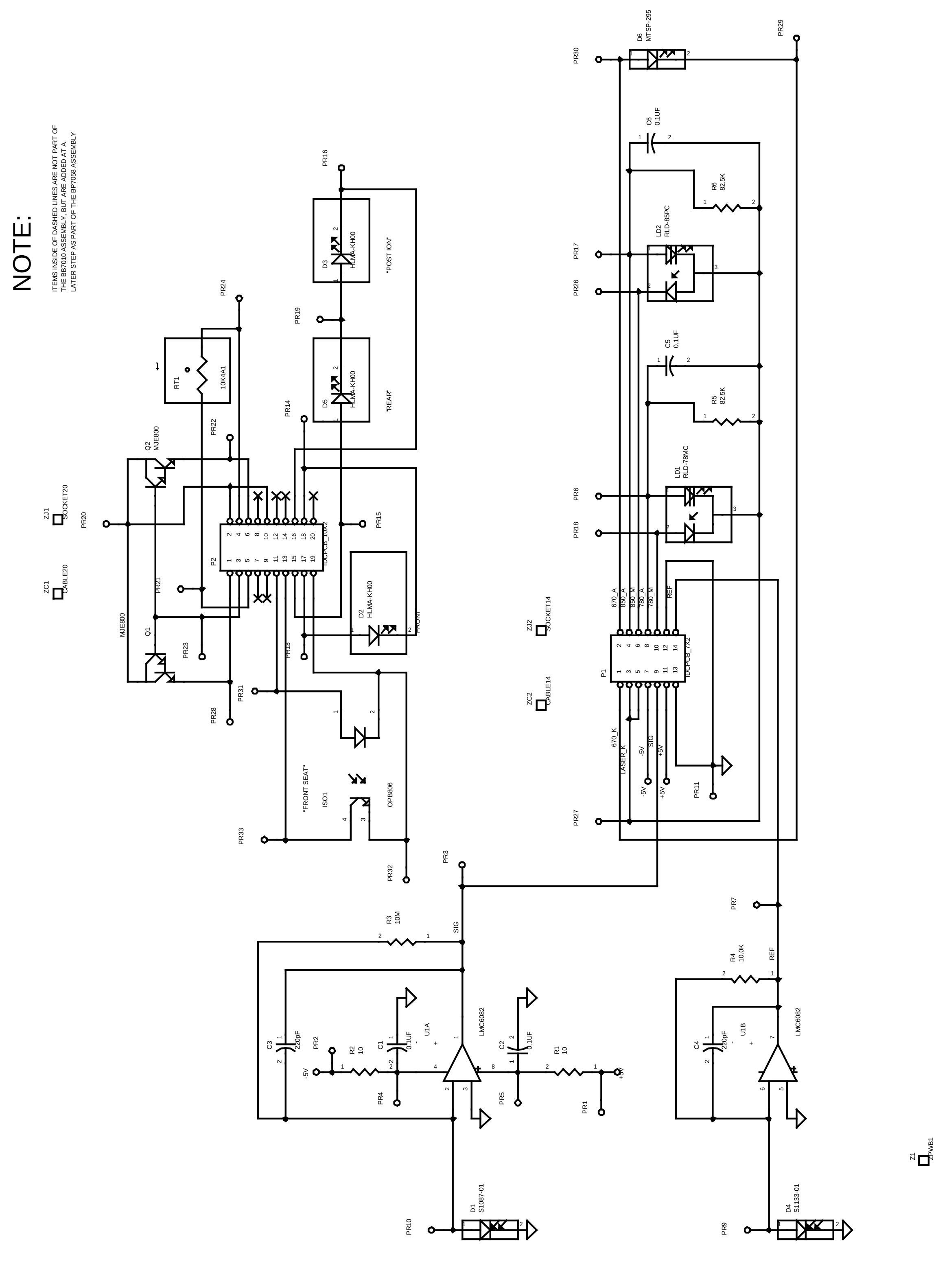

Gas Board
Bottom Heater 2
J1
CON3
Parts added later
Q1
MJE800
Q2
MJE800
TOP_EMIT_1G
TOP_EMIT_2G
R1
1 ohm
R2
1 ohm
R3
1 ohm
R4
1 ohm
TOP_BASE
TOP_EMIT_2I
TOP_EMIT_1I
COLLECTOR
BOT_BASE
BOT_EMIT_1
BOT_EMIT_2
J2
7X2 IDC/PCB
Z11
6X2 IDC
ZC3
HEATER CABLE
Parts added later
LED 1
LED 2
LED 3
D1
D2
D3
LED
LED6_A
LED6_C
LED5_A
LED5_C
LED4_A
LED4_C
LED1_A
LED2_A
LED3_A
LED1_C
LED2_C
LED3_C
J6
7X2 IDC/PCB
RT1
THERMISTOR
ZC4
LED CABLE
Z12
7X2 IDC

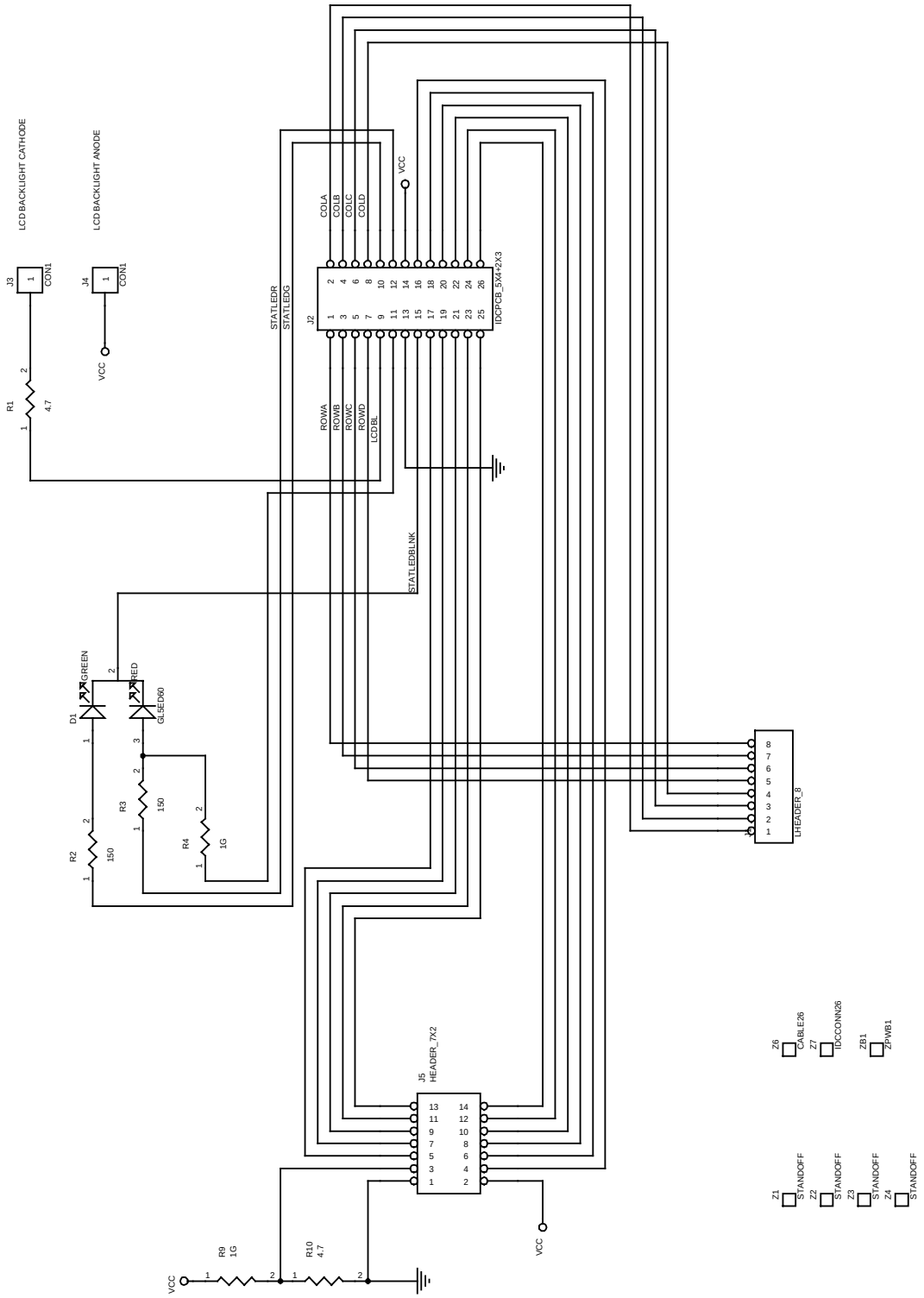
OPTICS MODULE - LED's ION and Heaters Sheet 3

Ion Board

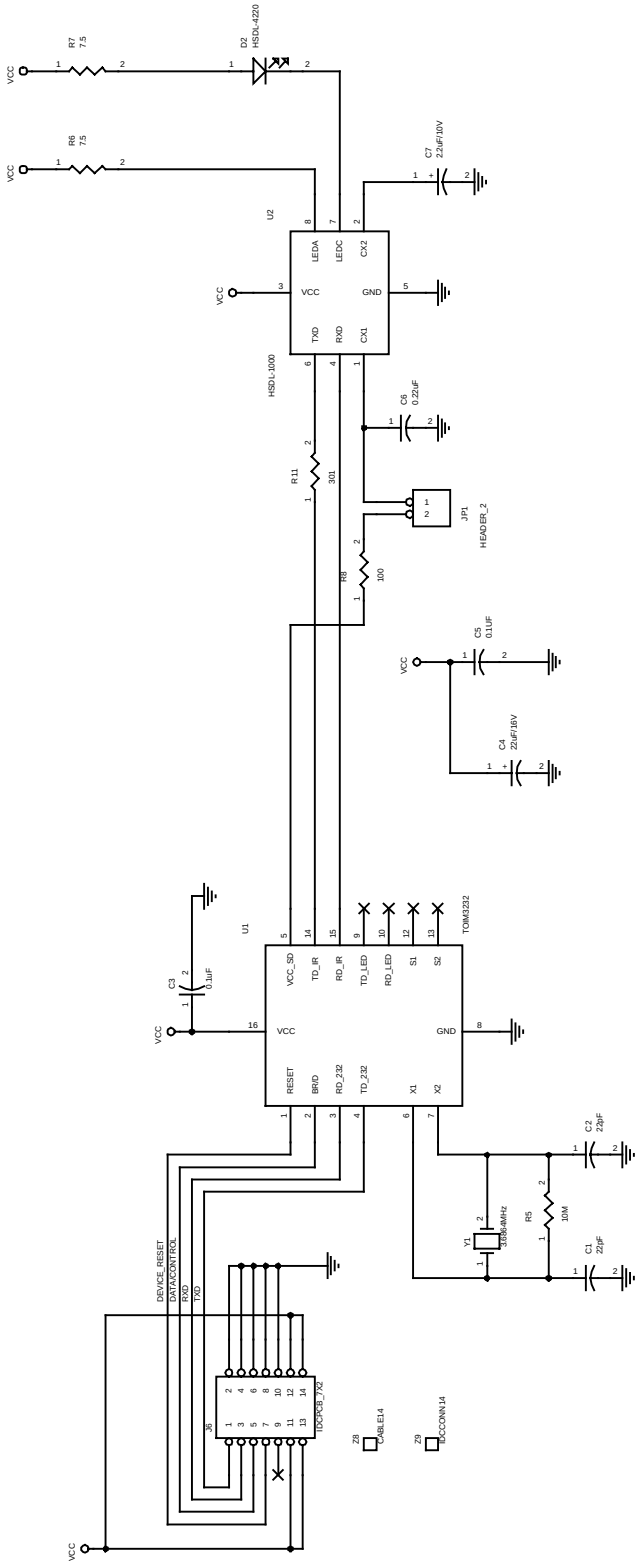


OPTICS MODULE - SMC HEATER/tHb Board Sheet 1




LCD BACKLIGHT CATHODE
LCD BACKLIGHT ANODE
J3
J4
CON1
R1
4.7
VCC
J2
IDCPCB_5X4+2X3
COLA
COLB
COLC
COLD
ROWA
ROWB
ROWC
ROWD
LCDBL
STATLEDR
STATLEDG
STATLEDBLNK
D1
GREEN
RED
GL5ED60
R2
150
R3
150
R4
1G
J1
LHEADER_8
J5
HEADER_7X2
R9
1G
R10
4.7
Z1
STANDOFF
Z2
STANDOFF
Z3
STANDOFF
Z4
STANDOFF
Z6
CABLE26
Z7
IDCCONN26
ZB1
ZPWB1

DISPLAY IR Board - IR Circuit Sheet 2



10 Illustrated Parts List

OPTI 1 System

The Illustrated Parts List for the AVL OPTI 1 and OPTI CCA analyzers are included to provide service personnel with part location diagrams. Please note that parts, which are specific to one type of analyzer only, are identified in the part description as to the appropriate analyzer type. The following diagrams are provided with a corresponding reference to the current part number:

Main Upper Housing (Outer View)

Main Upper Housing (Inner View)

Lower Housing Assembly

Printer Assembly

SMC Assembly

Gas Module Assembly

Display Assembly

Battery Receptacle

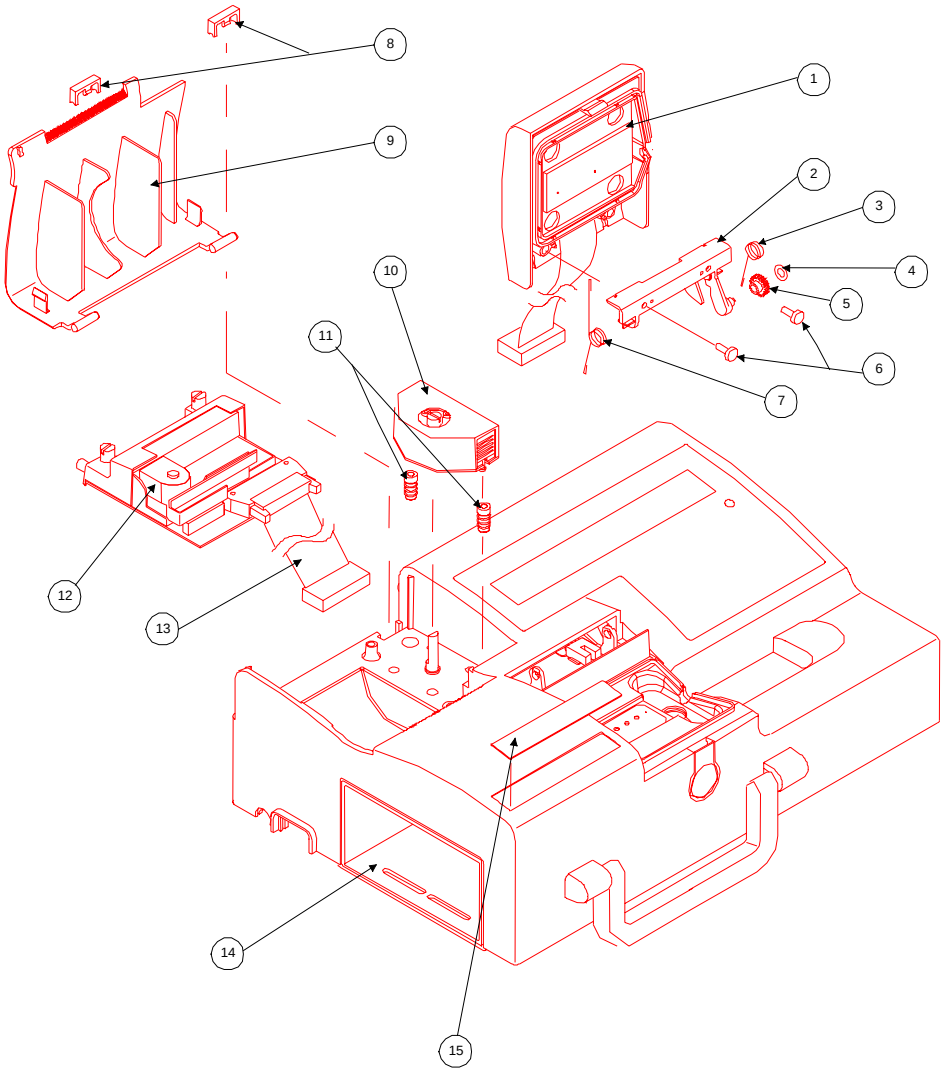
SMC Top Cover Assembly

Top Heater Plate

Main Upper Housing (Outer View)

Item	Part Number	Description
1	BP7022	ASSEMBLY: SMC Cover OPTI 1
1a	BP7047	ASSEMBLY: SMC Cover OPTI CCA ** Not available as a spare part*
2	RE7009	PLATE: Retainer Plate Hinge Shaft
3	DF7001	SPRING: Torsion
4	DZ7006	RETAINER: Shaft
5	RE7035	GEAR: SMC Cover
6	DS7016	SCREW: M# X 8 PPH
7	DF7001	SPRING: Torsion
8	RE7034	RETAINER: Printer Cover
9	RE7028	COVER: Printer Access
10	BP7012	ASSEMBLY: Peri Pump Cartridge
11	RE7026	RECEPTACLE: Pump Cartridge
12	BP7011	ASSEMBLY: Printer
13	BK7001	CABLE: Printer
14	BP7017	ASSEMBLY: Battery Receptacle
15	ZB7002	LABEL: Name Plate OPTI

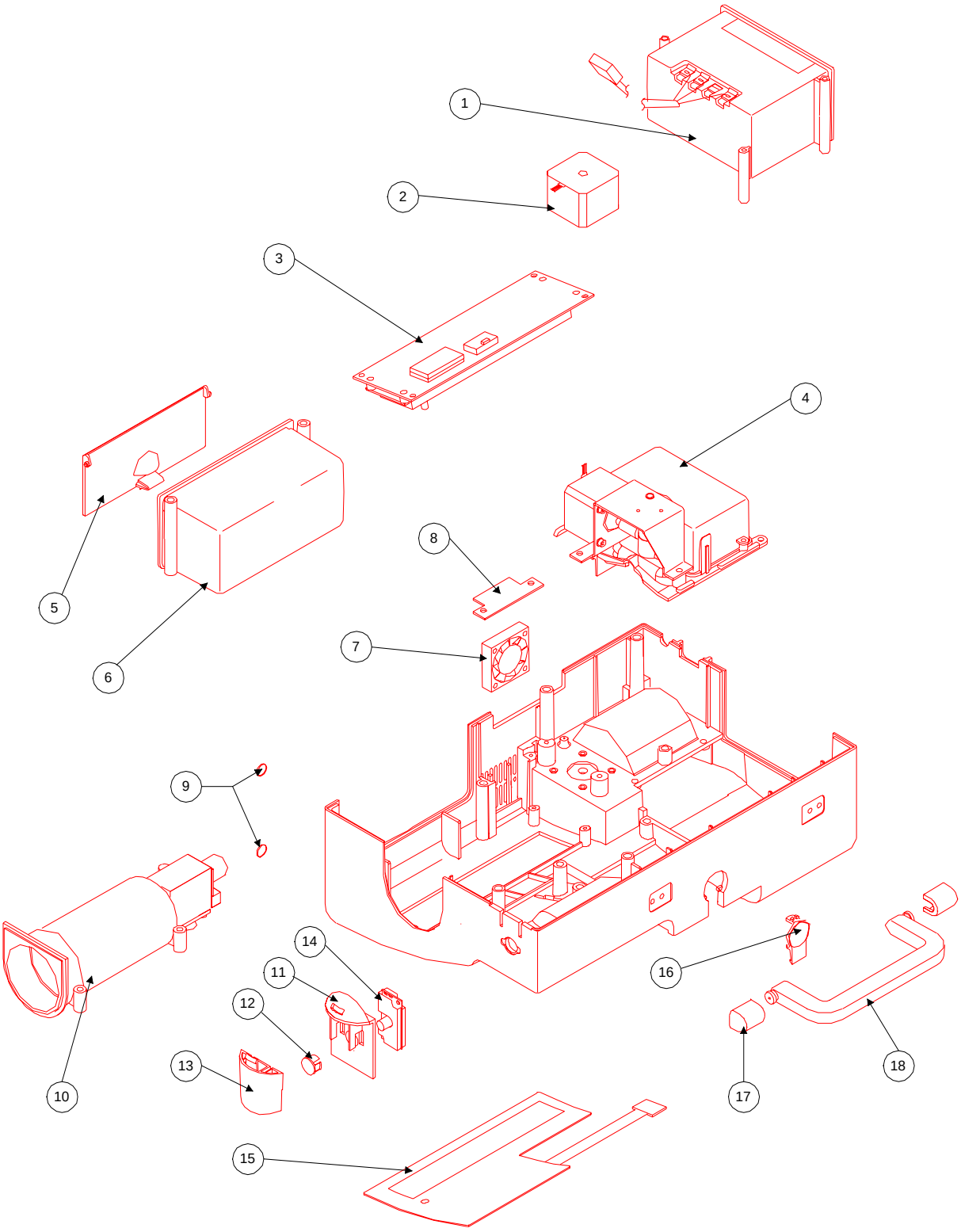
Main Housing Assembly (Outer View)



Main Upper Housing (Inner View)

Item	Part Number	Description
1	BP7017	ASSEMBLY: Battery Receptacle
2	BP7027	ASSEMBLY: Pump Motor
3	BP7016	ASSEMBLY: Display OPTI 1
3a	BB7013	ASSEMBLY: Display IR OPTI CCA
4	BP7018	ASSEMBLY: SMC OPTI 1
4a	BP7053	ASSEMBLY: SMC OPTI CCA
5	RE7024	DOOR: Storage Compartment
6	RE7023	COMPARTMENT: Storage
7	BP7013	ASSEMBLY: Exhaust Fan
8	YB7008	RETAINER: Fan
9	MB7005	FOOT: Adhesive
10	BP7015	ASSEMBLY: Gas Module
11	RE7036	FRAME: Bar Code
12	RE7027	LENS: Bar Code
13	RE7018	GUIDE: Bar Code
14	EL7001	READER: Bar Code
15	YB7001	PANEL: Control
16	RE7025	LATCH: SMC Cover
17	RE7032	PIVOT: Handle
18	BP7030	HANDLE: Complete OPTI

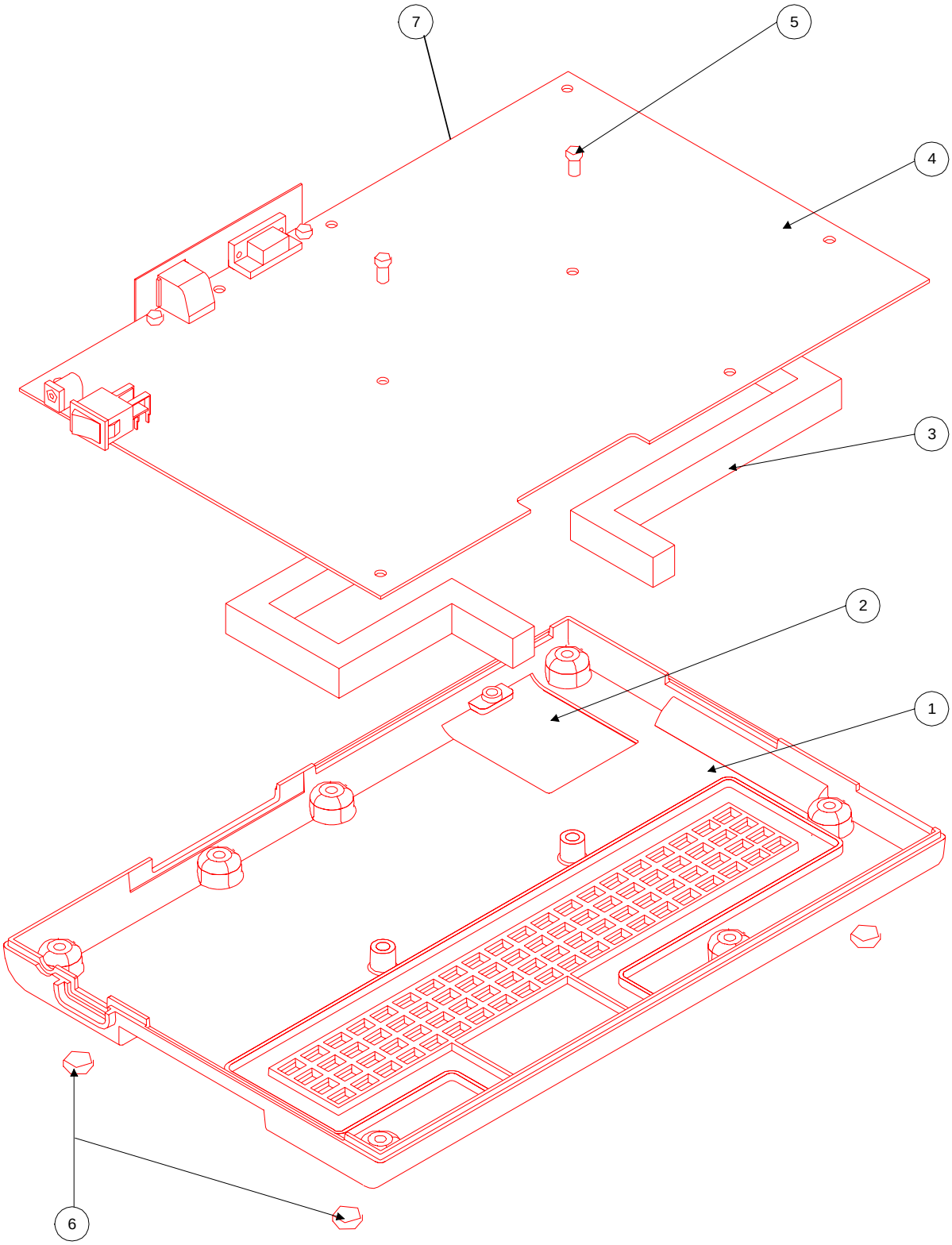
Main Housing (Inner View)



Lower Housing Assembly

Item	Part Number	Description
1	RE7010	HOUSING: Lower Main
2	RE7029	COVER: EPROM
3	HB7000	TAPE: Foam Adhesive
4	BB7008	ASSEMBLY: Main PCB OPTI 1
4a	BB7011	ASSEMBLY: Main PCB OPTI CCA ** Not available as a spare part*
5	DS0168	SCREW: Phillips Pan Head DIN 7985 M4 X 8
6	MB7005	FOOT: Adhesive
7	BP7028	PROGRAM SET: OPTI 1
7a	BP7060	PROGRAM SET: OPTI CCA

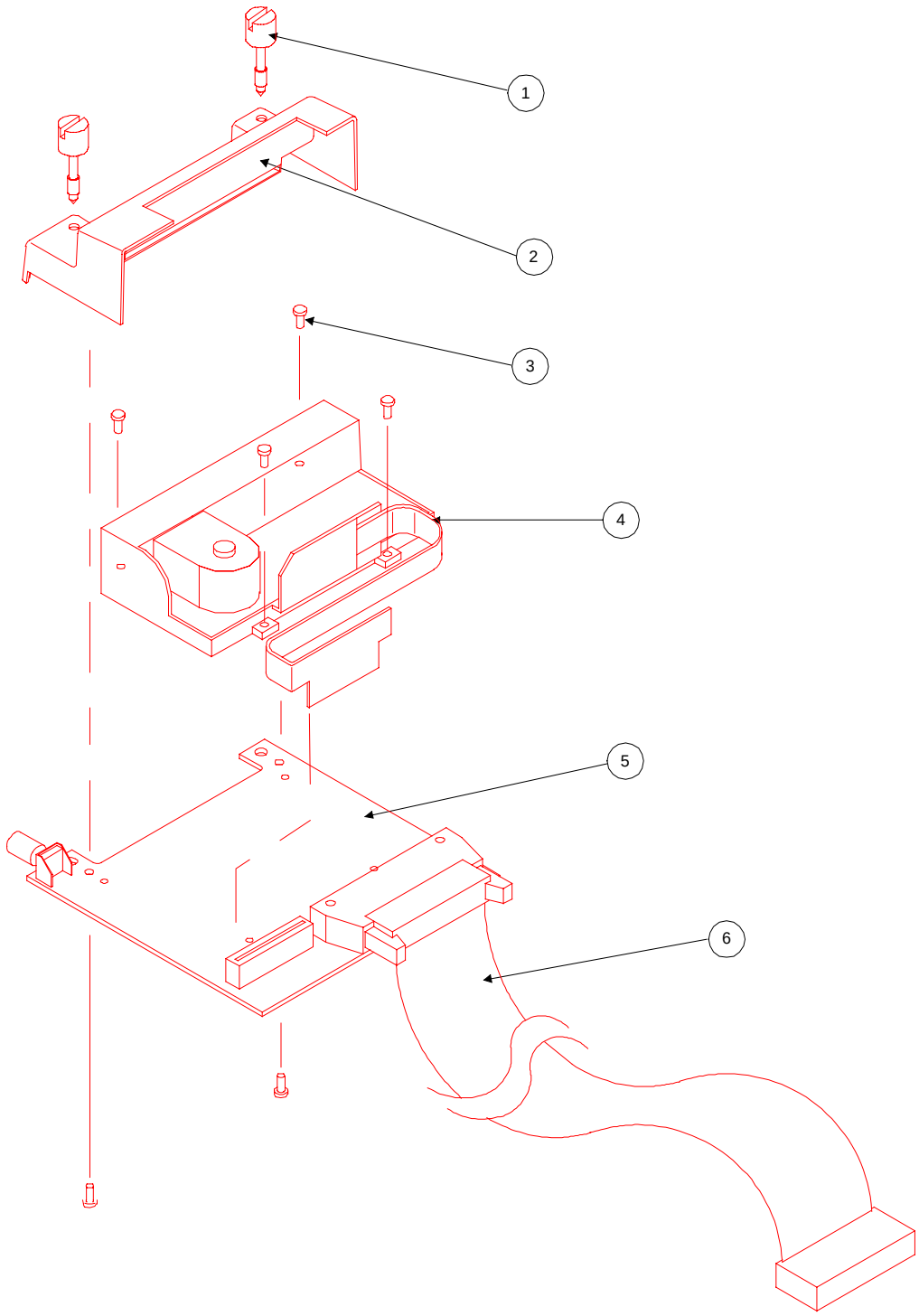
Lower Housing Assembly



Printer Assembly

Item	Part Number	Description
0	BP7011	ASSEMBLY: Printer
1	DS7005	SCREW: Thumb Slotted
2	RE7031	COVER: Printer Inner
3	DS7009	SCREW: M2 X 4 PPH
4	MB7000	PRINTER: OPTI
5	BB7003	ASSEMBLY: PCB Printer
6	BK7001	CABLE: Printer Assembly

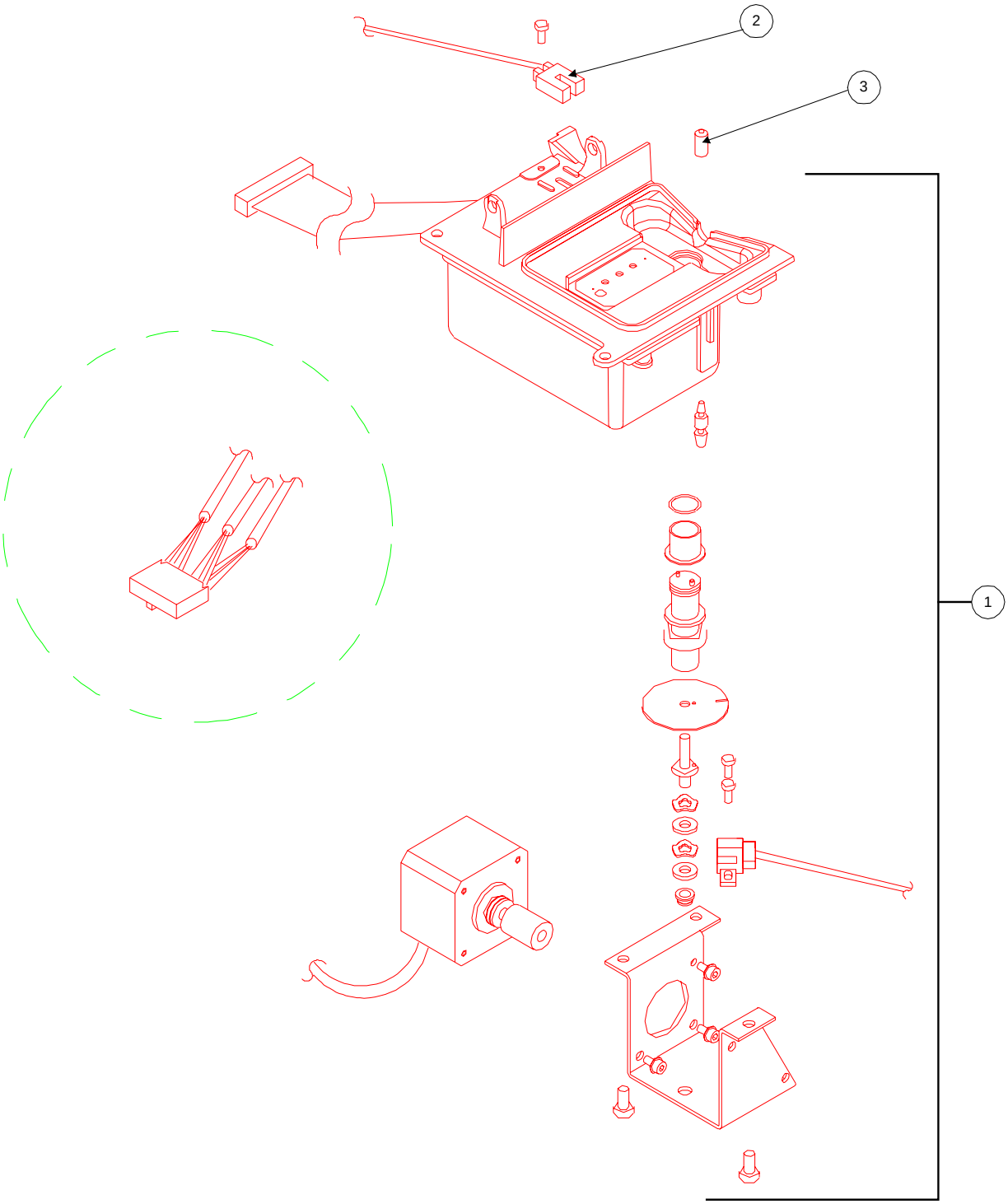
Printer Assembly



SMC Assembly

Item	Part Number	Description
1	BP7014	ASSEMBLY: SMC OPTI 1
1a	BP7018	ASSEMBLY: SMC OPTI CCA
2	ED5000	LIGHT GATE:
3	RE7030	SEAL: SMC Gas I/O Port

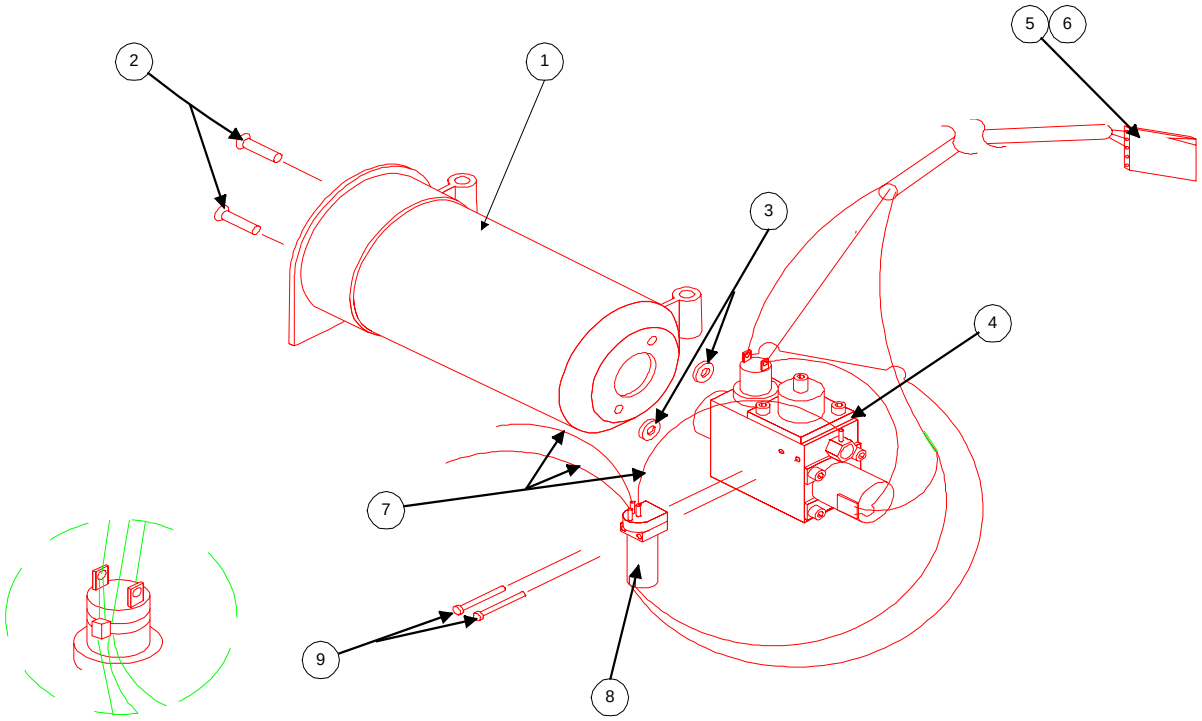
SMC Assembly



Gas Module Assembly

Item	Part Number	Description
0	BP7015	ASSEMBLY: Gas Module
1	RE7014	HOUSING: Gas Module
2	DS7000	SCREW: CSF Phillips 6-32 X .375 Self Locking
3	YB7015	SPACER: Gas Module
4	MB7001	REGULATOR: Gas
5	EU7002	CONNECTOR: 5 Pin Locking
6	EU5005	PIN: Connector Amp # 530151-6
7	SS0063	TUBING: Tygon
8	MB7002	VALVE: Gas
9	DS7001	SCREW: M2 X 14

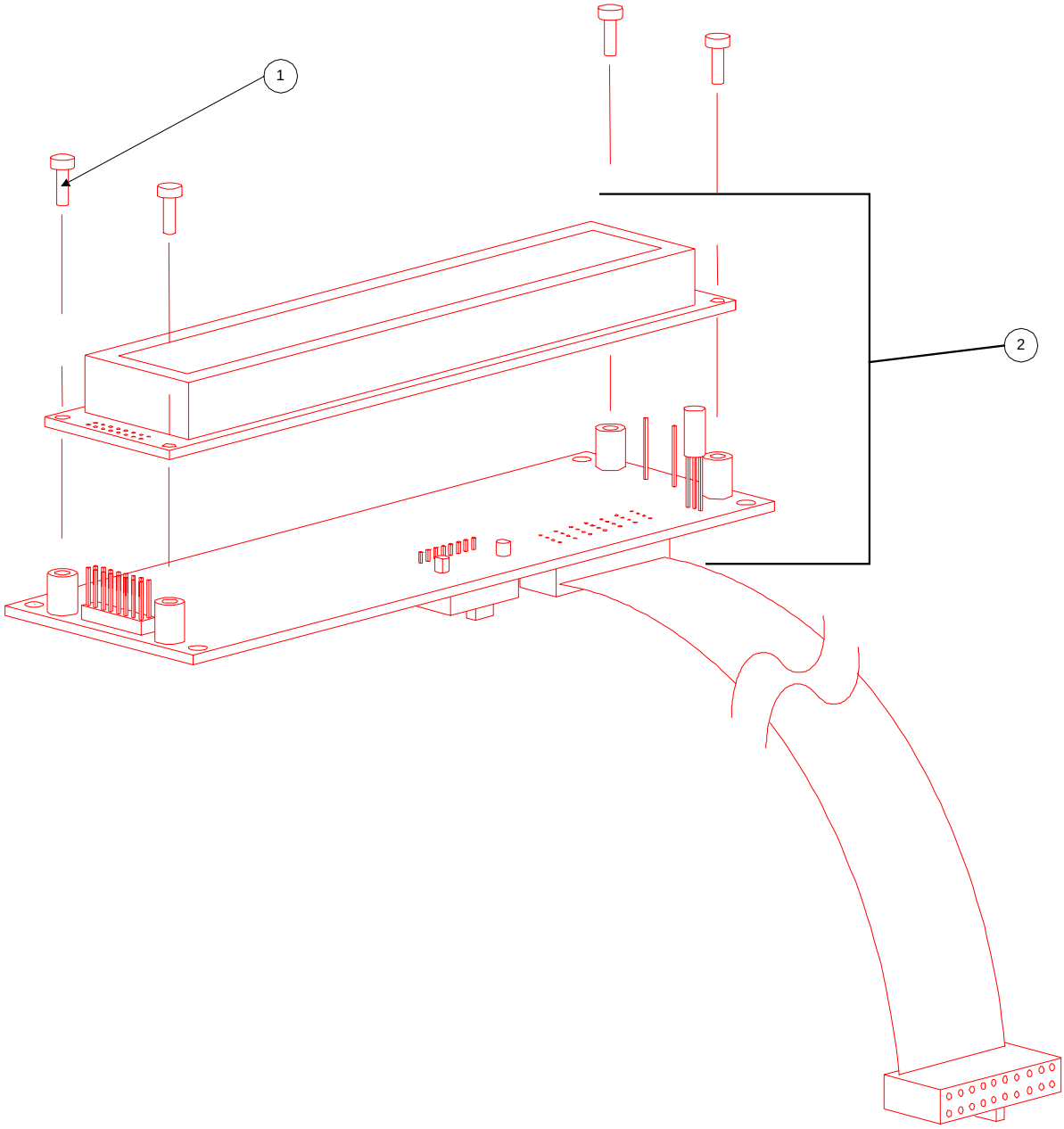
Gas Module Assembly



Display Assembly

Item	Part Number	Description
1	DS7012	Screw: M3 X 6
2	BP7016	Assembly: Display OPTI 1
2a	BB7013	Assembly: Display IR OPTI CCA

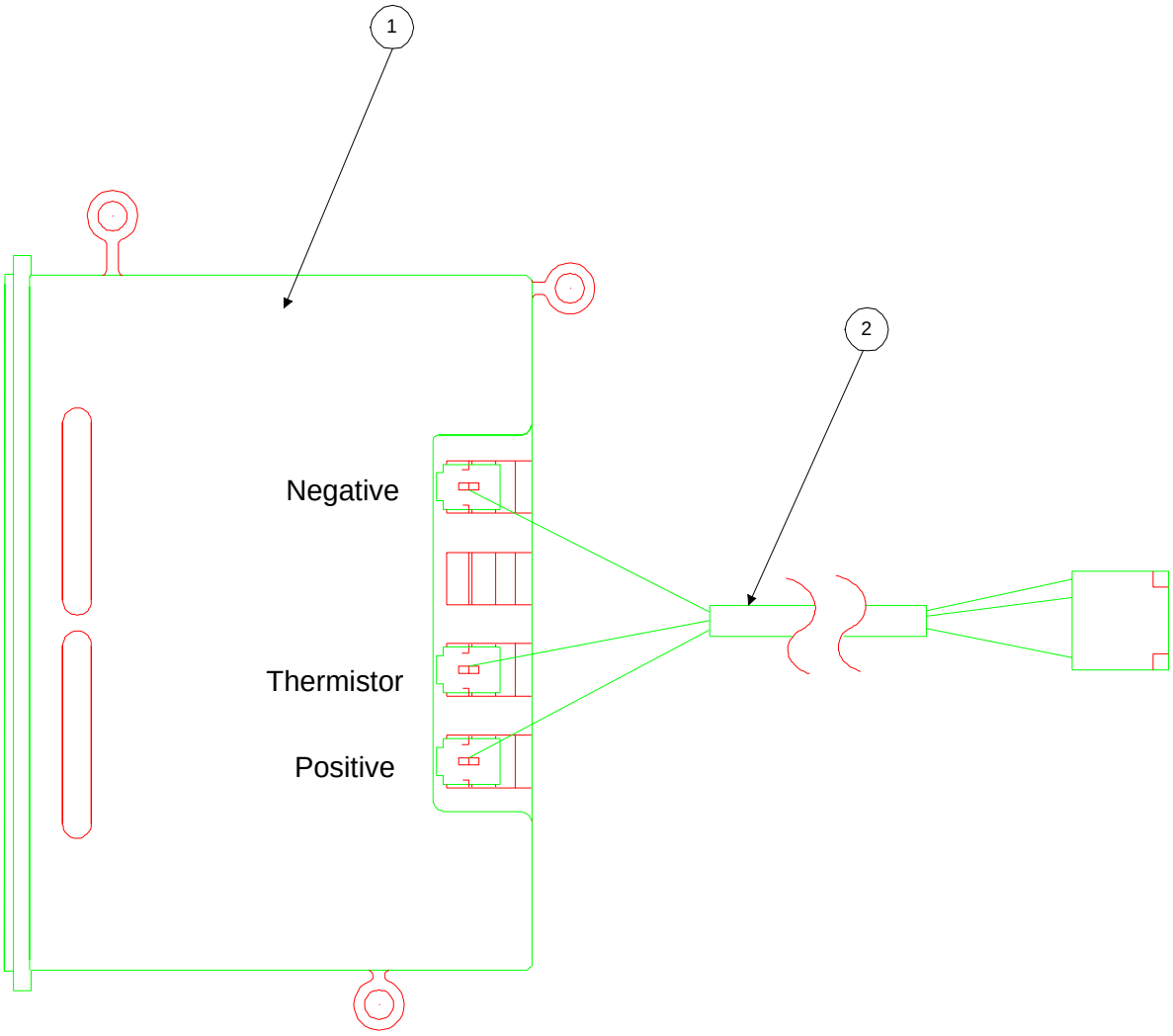
Display Assembly



Battery Receptacle Assembly

Item	Part Number	Description
0	BP7017	ASSEMBLY: Battery Receptacle
1	RE7013	HOUSING: Battery Receptacle
2	BK7003	CABLE: Battery Receptacle

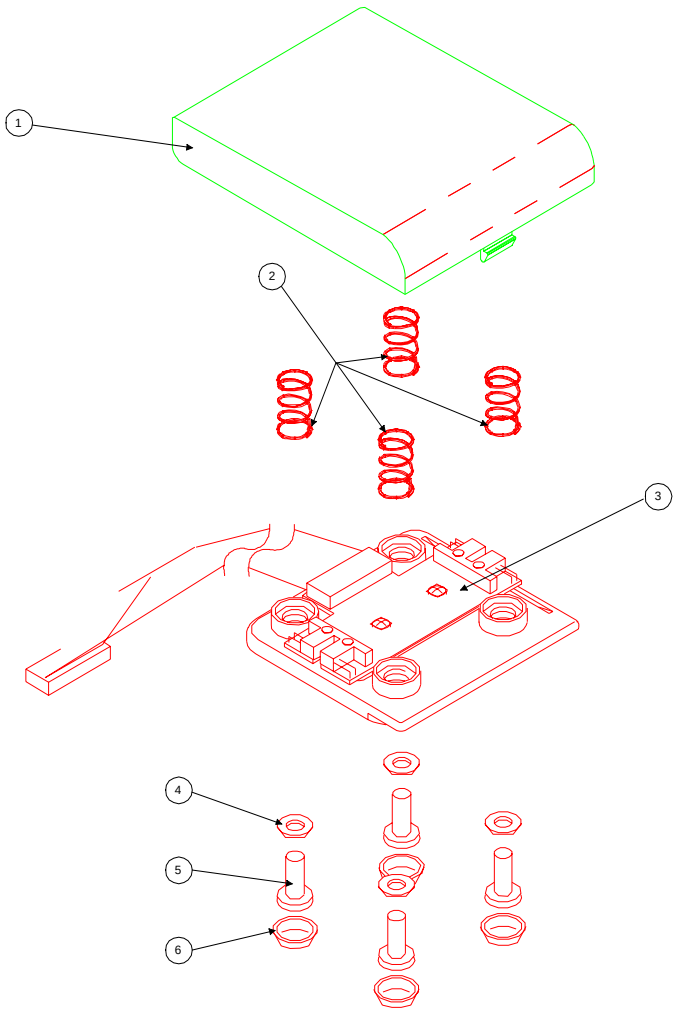
Battery Receptacle



SMC Top Cover Assembly

Item	Part Number	Part Description
0	BP7022	ASSEMBLY: SMC Cover, Complete OPTI 1
0a	BP7047	ASSEMBLY: SMC Cover, Complete OPTI CCA ** Not available as a spare part*
1	RE7008	COVER: SMC
2	DF7002	SPRING: SMC Cover Compression
3	BP7023	ASSEMBLY: Upper Heater Plate Carrier
3a	BP7058	ASSEMBLY: Heater Plate/tHb Block OPTI CCA ** Not available as a spare part*
4	DZ7004	WASHER: For AB No. 8 Screw
5	DS7013	SCREW: AB No. 8 X .5 inch Phillips
6	DZ7005	CAP: Black AB No. 8

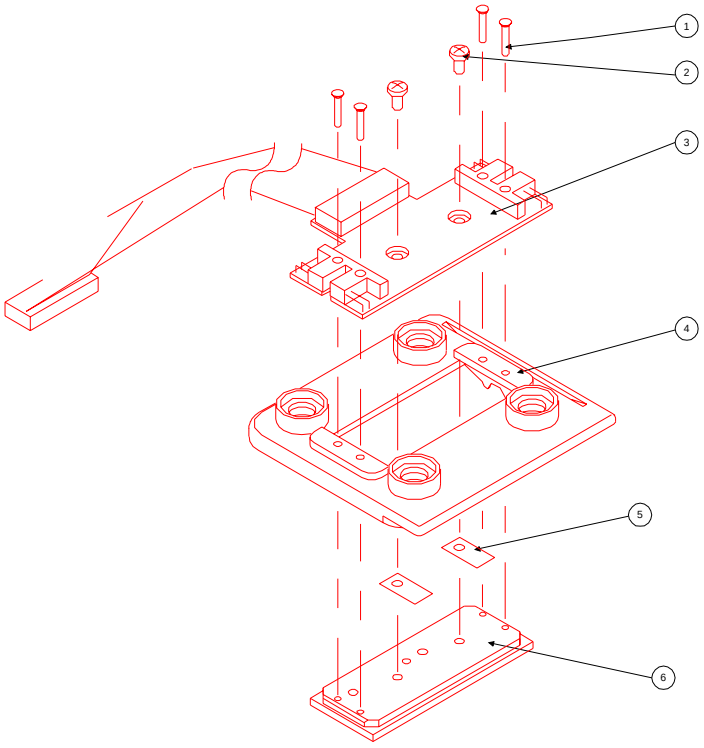
SMC Top Cover Assembly



SMC Top Plate Assembly (OPTI 1 Only)

Item	Part Number	Part Description
1	DS7014	SCREW: M2 X 12 PPH
2	DS7012	SCREW: M3 X 6
3	BB7004	ASSEMBLY: PCB Heater
4	RE7007	CARRIER: Upper Heater Plate
5	YA5022	INSULATOR: Transistor for Heater Module
6	YB7011	PLATE: Upper Heater

SMC Top Plate Assembly (OPTI 1 Only)



11 Service Spare Parts

OPTI System

The AVL OPTI 1 and OPTI CCA instruments are field repairable. Several assemblies require factory adjustment or alignment and field repair of these assemblies should be limited to assembly replacement. These parts are indicated by an "*". Parts that are used only within either OPTI 1 or OPTI CCA are indicated. All other parts can are used in either instrument. A list of recommended spare parts is provided below.

Recommended Spare Parts List

*	BP7007		ASSEMBLY, BATTERY
*	BP7012		ASSEMBLY, CARTRIDGE, PERI-PUMP
	RE7034		RETAINER, COVER, PRINTER ACCESS
	RE7028		COVER, PRINTER ACCESS
	RE7029		COVER, EPROM
	BP7028	OPTI 1	PROGRAM SET, OPTI 1
	BP7060	OPTI CCA	PROGRAM SET, OPTI CCA
	DS7008		SCREW, M4 X 76
	DS7007		SCREW, M4 X 12
	BB7008	OPTI 1	ASSEMBLY, PCB, MAIN, OPTI 1
	MB7005		FOOT, ADHESIVE
	RE7026		RECEPTACLE, PUMP CARTRIDGE
	DS7006		SCREW, M3 X8, PFH
	BP7027		ASSEMBLY, MOTOR, PUMP
	BP7013		ASSEMBLY, FAN, EXHAUST
	DS7003		SCREW, M4 X 50
*	BP7015		ASSEMBLY, GAS MODULE
	DS7001		SCREW, M2 X 14, PPH
	MB7002		VALVE, GAS
	DS7000		SCREW, CSFH, PHILLIPS, 6-32 X .375, SELF
	RE7024		DOOR, COMPARTMENT, STORAGE
	RE7023		COMPARTMENT, STORAGE
	DS7004		SCREW,M4 X 20, PPH
	BP7017		ASSEMBLY, RECEPTACLE, BATTERY
	BP7011		ASSEMBLY, PRINTER
	BP7016	OPTI 1	ASSEMBLY, DISPLAY OPTI 1
	BB7013	OPTI CCA	ASSEMBLY, DISPLAY IR OPTI CCA
	YB7001		PANEL, CONTROL
	DS7016		SCREW, M3 X 8, PPH

	BP7022	OPTI 1	ASSEMBLY, COVER, SMC OPTI 1
	DS7013		SCREW, AB NO.8 X .5 INCH CUSTOM PHILLIPS
	DZ7004		WASHER, FOR AB NO. 8 SCREW
	DF7002		SPRING, COMPRESSION, SMC COVER
	DZ7005		CAP, BLACK, AB#8 CUSTOM
	DF7001		SPRING, TORSION
	RE7009		PLATE, HINGE, RETAINER, SHAFT
*	BP7014	OPTI 1	ASSEMBLY, SMC OPTI 1
*	BP7018	OPTI CCA	ASSEMBLY, SMC OPTI CCA
	RE7030		SEAL, GAS 1/0 PORT, SMC
*	BP7020		ASSEMBLY, MOTOR, VALVE DRIVE
	EL7001		READER, BAR CODE
	RE7018		GUIDE, BAR CODE
	RE7027		LENS, BAR CODE
	RE7025		LATCH, SMC COVER
	BP7030		HANDLE, COMPLETE, OPTI
	YB7019		TUBE, PORT, CLEAN-OUT, OPTI
	YB5012		FITTING: TUBING REDUCER VALUE PLASTIC